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A STUDY OF SOME OF THE PROPERTIES OF WORSTED TYPE YARNS MADE FROM BLENDS OF VICARA AND WOOL FIBERS

BY MICHAEL J. KOROSKYS*

THE PURPOSE

The purpose of this paper was to study the effect of introducing a synthetic fiber, Vicara, into a fiber blend with a compatible type of wool.

For this purpose, four lots were manufactured as similarly as was possible. The percentage of the component fibers was as follows: 100% Wool—0% Vicara; 75% Wool—25% Vicara; 50% Wool—50% Vicara; and 25% Wool—75% Vicara. Each of these lots were spun to five levels of twist—i.e., 7, 7½, 8, 8½, and 9 turns per inch.

The properties selected to measure the characteristics of the yarns were tenacity, elongation, elastic resilience at 2% elongation, average stiffness, toughness index, length shrinkage, and openness index.

Using the above tests as a gauge, it was hoped that this paper would give some indication as to the effect of blending Vicara with wool.

There is very little data in the literature on this subject. Fibers are blended today from the standpoint of economics (to lower the price) or to achieve an esthetic quality. It is not expected that this, or similar work will change this situation.

It is, however, the purpose of this paper to provide a guide, which will indicate what results may be expected (within the limitations of this paper) when fibers are blended for the above reasons, and to add to our sum total knowledge so that an engineering approach to yarn construction may some day be possible.

FIBERS SELECTED

Wool and Vicara were selected for this paper since these fibers are more similar than other combinations, are processed commercially to produce blends of fabrics, and since the literature contains no data on such blends.

The wool selected was in the form of French combed sliver, which had been previously processed in the laboratories of Lowell Technological Institute. Fifteen pounds of this $56/58^s$ wool was obtained.

A 7-denier Vicara was used because it was the equivalent denier of the wool selected. Fifteen pounds of the Vicara tow was used.

MANUFACTURING PROCEDURE

The plan of procedure was to manufacture the yarns by utilizing the following operations: Pacific Converter, 3 operations of Warner & Swasey Pin Drafting, Reducing, Roving, and then Spinning.

The blends selected were 100% Wool—0% Vicara; 75% Wool—25% Vicara; 50% Wool—50% Vicara; 25% Wool—75% Vicara; and 0% Wool—100% Vicara. These categories are to be known henceforth as blends and their component parts will be designated by "W" for Wool and "V" for Vicara.

Each of the above blends was spun to a common yarn number—$1/18^s$. This number was chosen because the entire range of blends had to be spun to the same count and it was thought that the yarn number should be considerably below the limit spin of the poorest spinning portion of the range of blends so that uncontrollable variables be eliminated. The yarn number was arrived at arbitrarily—within the range permitted by the above reasoning.

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*Assistant Professor, Textile Manufacturing Division, Lowell Technological Institute.

Each blend was twisted to five levels of twist. Each level of twist will henceforth be referred to as a lot. Keeping in mind that too low a twist would cause a poor spin, and too high a twist would cause kinkiness, and that one range of twists must serve all of the blends, it was arbitrarily decided to select 8 turns per inch as the normal, and spin two increments on either side; i.e., 7, 7½, 8, 8½, and 9 TPI.

The controlled variables were blend percentage and twist, all manufacturing variables were held to a minimum.

In the actual processing, it was found advantageous to use the Holdsworth Gill Reducer for the first operation following the Converter, since this machine was equipped with coarse pinning of the fallers.

The 100% Vicara blend was dropped since it was not feasible to manufacture this blend the same way the others were manufactured, and introducing another method of manufacture would introduce another variable of unknown effect.

TENSILE LOAD AND ELONGATION TESTS

All the lots were spun on the same 5 spindles. These 5 bobbins per lot were then reeled into one skein 20 yards long. This skein was then weighed to get the yarn number of the yarn used in the Instron tests. This skein was then cut and the individual yarns were tested in the Instron machine. Thirty individual yarns were tested for each lot. All samples were conditioned under standard atmospheric conditions for 2 days before testing.

The Instron machine was set up with the 500 gram load cell on all the blends, and the 1000 gram load cell was used on the 100% wool since its higher strength required it. The tests were all run at a chart speed and a cross head speed of 10 inches per minute. The jaws were set at a sample length of 10″ for all the tests.

The Instron tester was found to be an extremely sensitive apparatus, and it was found that the yarn acted very erratically after it reached a point of deterioration; i.e., it would rupture completely, or it would continue to sustain a load, then the load capacity would decrease, and then increase (twist running into the thin spot would give it additional strength); or the yarn would continue elongation-sustaining the same load. Since the behavior of the yarn beyond the point of deterioration did not lend itself to graphical or mathematical analysis, it was decided to consider the yarns had reached an end point when the Instron curve swung upward sharply and started to wobble.

The load and elongation were measured at the chosen end point. The load was measured at 2% elongation. The load index was measured on the Instron charts and the average was computed for the 30 tests run per lot. The charts are 9.5″ wide and are divided into 10 main divisions across the chart. The load was measured by noting the number of these divisions and fractions thereof occurring in the distance from and perpendicular to the elongation line at 2%, to the point where this line intersects the curve. This measure was called the load index, since it was not grams, nor was it inches.

TWIST TESTS

The ASTM Untwist-Twist Method of determining the twist was used, using twenty 10″ samples for each lot.

All the yarn for each lot was wound on a cone. Each cone represented a random distribution of yarn on original bobbins.

The yarn was taken off the cone, exercising care not to lose twist, and 20 tests were made per cone.

YARN NUMBER DETERMINATION

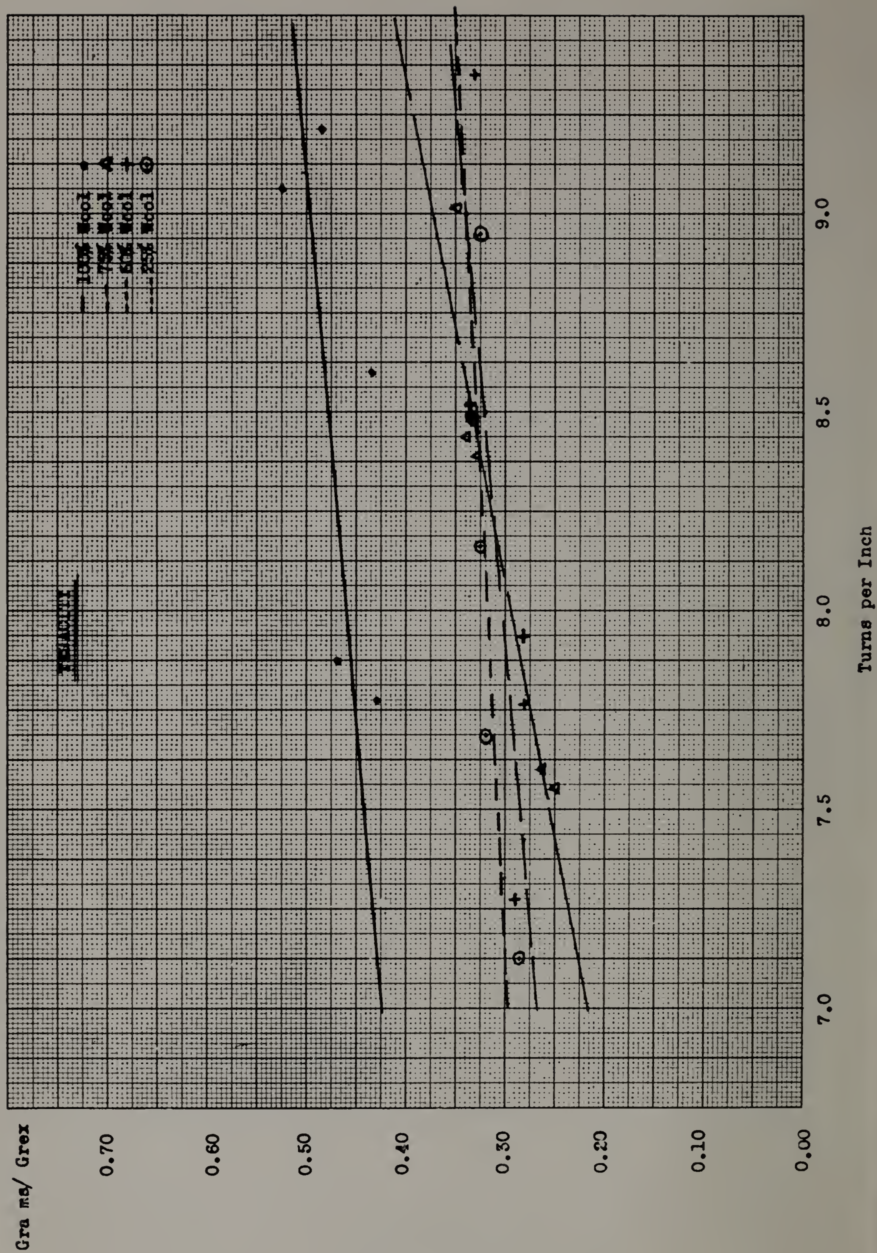
Three 80-yard samples of yarn were prepared from each lot to determine the yarn number for each lot. These were tested in accordance with ASTM methods.

SUMMARY OF RESULTS

Blend	Turns per Inch Nominal	Turns per Inch Actual	Tenacity	Percent Elongation	Elastic Resilience at 2% Elong.	Average Stiffness	Toughness Index	Length Shrinkage	Openness Index
100% Wool—0% Vicara	7.0	7.78	.430	8.09	.110	5.32	.174	4.39	1.96
	7.5	7.87	.462	8.98	.087	5.14	.207	3.54	2.26
	8.0	8.60	.432	9.34	.070	4.63	.202	4.15	3.36
	8.5	9.19	.482	12.63	.076	3.82	.304	4.80	2.43
	9.0	9.06	.525	13.93	.091	3.77	.366	4.80	1.99
75% Wool—25% Vicara	7.0	7.55	.253	4.91	.093	5.15	.0621	3.63	1.82
	7.5	7.60	.266	4.99	.083	5.33	.0664	4.35	1.61
	8.0	8.31	.335	5.79	.098	5.79	.0970	4.02	2.42
	8.5	8.43	.344	5.58	.112	6.16	.0960	4.12	1.96
	9.0	9.01	.354	5.47	.106	6.47	.0968	3.97	1.95
50% Wool—50% Vicara	7.0	7.28	.289	5.31	.117	5.44	.0767	4.64	2.24
	7.5	7.76	.282	5.26	.083	5.36	.0742	4.49	2.69
	8.0	7.93	.282	6.01	.089	4.69	.0847	4.19	1.97
	8.5	8.53	.336	4.79	.123	7.01	.0805	4.61	2.04
	9.0	9.37	.328	5.79	.120	5.66	.0950	4.50	2.81
25% Wool—75% Vicara	7.0	7.14	.282	5.89	.109	4.79	.0830	4.59	1.45
	7.5	7.69	.320	6.14	.112	5.21	.0982	4.73	1.45
	8.0	8.16	.323	5.76	.121	5.61	.0930	4.55	1.61
	8.5	8.47	.339	5.83	.123	5.81	.0988	4.40	1.62
	9.0	8.95	.324	5.04	.125	6.43	.0816	3.75	1.68

Units of measurement:

Tenacity—Grams per grex
Elongation—Percent
Elastic Resilience at 2% Elongation—Grams per square inch per grex
Average Stiffness—Grams per grex
Toughness Index—Grams per grex
Length Shrinkage—Percent
Openness Index—Ratio of volume of yarn to volume of equivalent solid cylinder



TENACITY

Figure 1 — turns per inch

OPENNESS INDEX

Openness index is the ratio of the volume of a chosen length of yarn to the volume of an equivalent solid of the same length and weight.

To obtain the data necessary to calculate the openness index, the yarn from each lot was measured at 100 points 2 inches apart. This diameter was measured under minimum compression by means of the Walen evenness tester (an optical-lever system).

SKEIN LENGTH SHRINKAGE TESTS

A test skein was prepared by reeling 10 yards on a 1-yard reel and tying the ends. Three such samples were prepared per lot.

The sample was looped over the clamping nut on the fixed end of a Suter Twist Tester. The other end of the skein was looped over the nut on the sliding jaw and a minimum weight was applied—just sufficient to straighten any kinks in the yarn. The length of the sample was then read on the scale on the tester.

After all the samples had been measured, they were loosely wrapped in cheese cloth and immersed in boiling water for one-half an hour.

The samples were then air dried—in standard atmosphere—flat on a rack. When dry, they were remeasured under conditions identical to the original conditions, and the shrinkage expressed in percent.

PERCENTAGE NON-UNIFORMITY

Pacific Evenness Data

	100%W—0%V		75%W—25%V		50%W—50%V		25%W—75%V	
	Avg. %	Max.%	Avg. %	Max. %	Avg. %	Max. %	Avg. %	Max. %
Comb Sliver	18.2	37.6						
Converter			44.4	57.1	43.0	54.1	40.0	47.9
Holdsworth	11.6	18.4	17.6	32.0	21.0	49.0	24.4	37.4
1st W&S	10.7	22.8	11.4	16.7	9.9	18.8	16.6	26.2
2nd W&S	10.7	15.5	12.8	29.2	10.8	15.8	11.1	21.9
Reducer	22.1	33.8	26.4	38.3	22.6	38.0	19.6	43.1
Rover	33.0	50.2	36.1	51.5	34.1	45.1	31.2	48.8
Spinning								
Nominal TPI								
7	68.0	101.5	71.2	108.0	57.0	81.5	53.1	81.5
7½	58.0	98.8	69.0	95.0	59.5	104.0	54.5	83.8
8	61.5	88.5	68.0	100.8	56.5	85.6	57.8	88.9
8½	61.0	87.0	70.0	100.8	58.6	92.0	57.0	84.0
9	60.2	81.6	73.8	124.0	62.0	119.0	61.6	89.0

DISCUSSION AND CONCLUSIONS

Tenacity

It was thought that tenacity would be a good criterion for judging the effects of introducing various amounts of Vicara into a blend with wool, as long as other variables were held to a minimum.

The yarns were manufactured quite similarly, the uniformity was measured and found well within the commercial limits. Any large difference in the uniformity of the yarns between the lots would obscure the effect of the various percentages of Vicara introduced into the blends. This variable was held to a minimum.

Non-uniformity in the yarns came from two sources; namely, a) use of dissimilar fibers, b) specific gravity of the fibers.

The component fibers in the blend acted differently in the drafting field

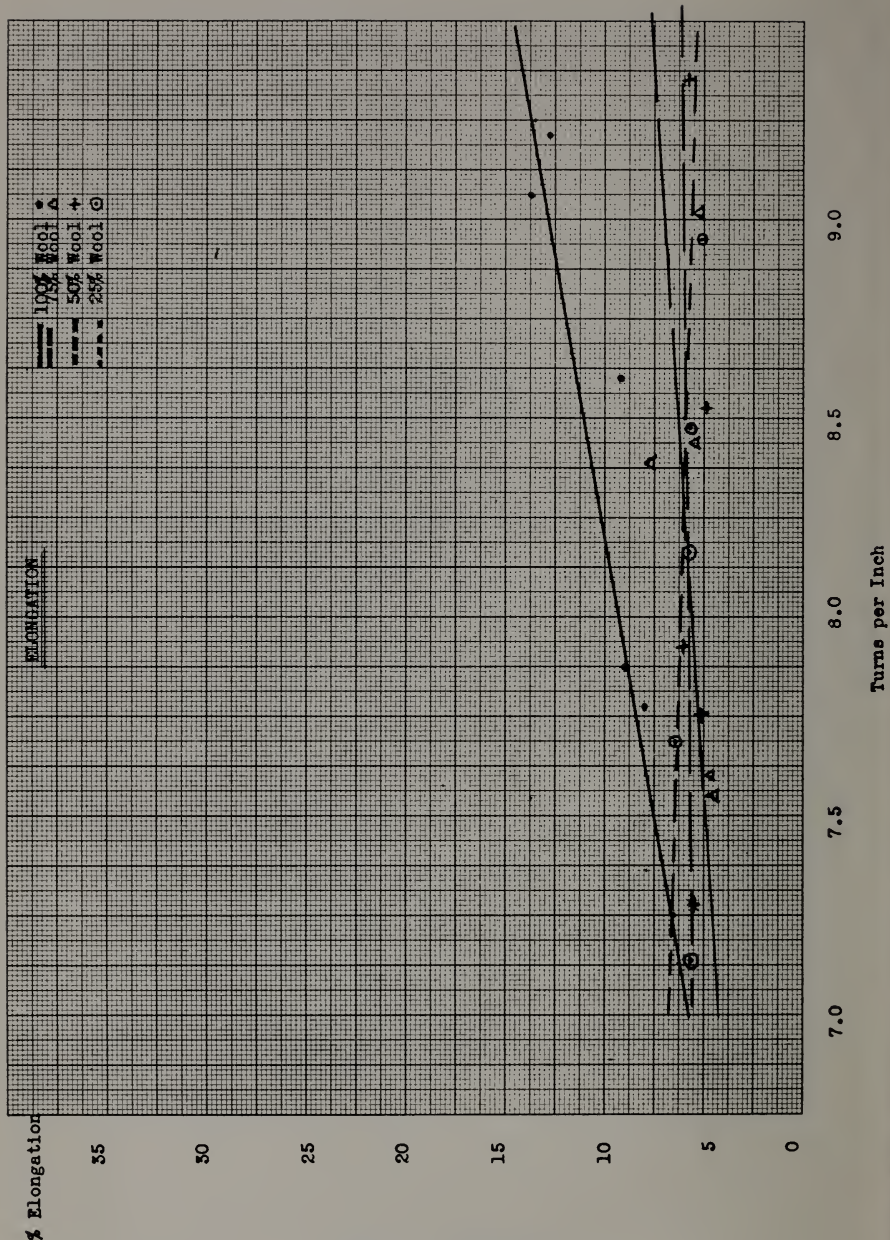


Figure 2 — Elongation

due to difference in interfiber friction. The drawing equipment, which utilizes pin control, exerts its control by fibers in the nip of the rolls influencing other fibers as they are drawn forward. If the components differ greatly in their interfiber friction, there is a tendency for unblending, i.e., separating into component parts rather than mixing intimately. In the drawing operations, which use twist control, each fiber is controlled in relationship with adjacent fibers by interfiber friction. If the components differ greatly in this respect, there is a tendency toward grouping. Proper utilization of a "drag" lubricant tended to nullify the natural differences in interfiber friction.

A difference in specific gravity of the components of the blend tended to cause grouping of the fibers due to the centrifugal forces which exist in the flyer drawing and ring spinning operations. The heavier component tended to work to the surface. This was held to a minimum by utilizing fibers whose specific gravities were close.

Preliminary work with the microscope indicated adjacent cross sections of yarn contained different amounts of the components, and that they were arranged differently within the perimeter of the cross section.

Tenacity then is believed to be a measure of the interfiber friction of the components of the blend. It is also a measure of the ability of the fibers to spin into a uniform yarn, i.e., a yarn which is uniform in cross section and also has its components uniformly distributed throughout its length and cross section.

Generally speaking, a study of the graph of tenacity (Figure 1) leads to the following conclusions. The introduction of any Vicara into a blend with wool resulted in a considerable lowering of tenacity. All blends of Vicara with wool sought a common level well below that of 100% wool.

Increasing the turns per inch caused the tenacity to increase in all the yarns; however, the rate of increase changed for the different blends, i.e., 75%W—25%V had the greatest rate, with 100%W—0%V and 50%W—50%V being about equal, and 25%W—75%V close to a zero rate.

Twist affected the tenacity since it affected the interfiber friction. The effect of twist (within the range studied) became less as the yarn approached 100%V since the synthetic tends to pack more readily than wool. The bulkiness of wool required twist to increase the interfiber friction by forcing the yarn into a smaller diameter and forcing the fibers closer. Therefore, a packed yarn would be affected less for the same twist increase than would a more open type of yarn.

It was concluded that any desired tenacity (within limits) could be achieved by judicious choice of percentage of each component and the turns per inch.

ELONGATION

It was found that an increase in Vicara in the blend decreased the elongation of the yarn.

It was also found that the introduction of Vicara into the blend brought all the yarns down to a common level below that of 100% wool.

Increasing the turns per inch resulted in changing the slopes of the curves from that of 100% wool.

A study of the graph of elongation (Figure 2) indicated that a careful selection of percentage of components of the blend and of turns per inch would obtain the desired elongation for any desired yarn.

The lack of wool-type crimp and the packing effect of the Vicara caused the change in elongation characteristics shown on the graph.

Elastic Resilience at 2 Percent Elongation

In studies from the data obtained, it was noted that as the turns per inch increased, the resilience of 100% wool decreased. Wool would have its greatest resilience at zero twists, at the low load, since its elongation would be that of

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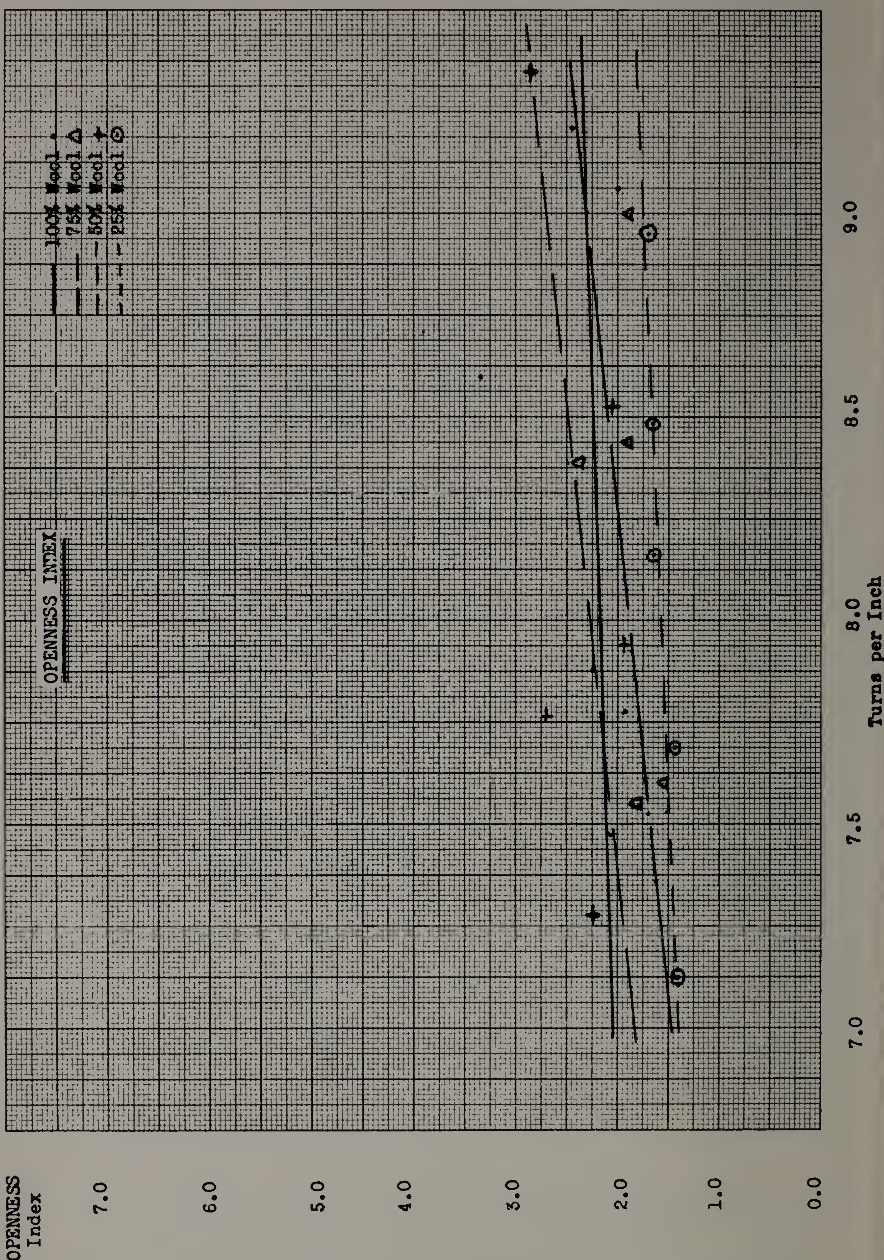

Figure 4 — Openness Index

tenacity could be achieved by judicious choice of TPI and percentage of each component in the blend.

Elongation decreased as the amount of Vicara in the yarn increased. Upon the introduction of Vicara into the blend, the level of elongation of all blends fell below that of 100% wool. It was concluded that for any desired elongation in yarn, a careful selection of TPI and percentage of components in the blend would be necessary.

Elastic resilience at 2 percent elongation decreased as the TPI increased since wool would have its greatest resilience at zero twist—at a low load—since then the movement would be that of the crimp in the wool. The opposite was true of the blends of wool and Vicara since the natural crimp in the wool was not allowed freedom of movement and the resilience came from the twist contraction in the yarn.

BULLETIN OF THE

LOWELL TECHNOLOGICAL INSTITUTE

Lowell, Mass.

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Catalogue Issue

1954 - 1955

Aerial View of Campus

New Administration-Auditorium Building Under Construction

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TABLE OF CONTENTS

The Institute reserves the right to make changes in the regulations, courses, and charges announced in this Bulletin.

INSTITUTE CALENDAR

FOR

ACADEMIC YEAR 1954-1955

1954

September 13, Monday, 9 A.M.	Freshman Orientation Week begins.
September 16, Thursday, 9 A.M.	Registration of Upperclassmen.
September 17, Friday, 9 A.M.	Registration of Upperclassmen.
September 20, Monday, 9 A.M.	Registration of Graduate Students. Undergraduate classes begin.
September 21, Tuesday, 9 A.M.	Graduate classes begin.
October 1, Friday	Last day to register for new classes.
October 12, Tuesday	Columbus Day. Institute closed.
October 15, Friday	Last day to drop classes without penalty.
November 11, Thursday	Armistice Day. Institute closed.
November 24, Wednesday, 12 Noon to November 29, Monday, 8 A.M.	Thanksgiving recess.
December 17, Friday, 5 P.M. to January 3, 1955, Monday, 8 A.M.	Christmas recess.

1955

January 3, Monday, 8 A.M.	Classes resume.
January 24, Monday, 8 A.M. to February 4, Friday, 5 P.M.	First semester examinations and registration for second semester.
February 7, Monday, 8 A.M.	All classes begin.
February 18, Friday	Last day to register for new classes.
February 22, Tuesday	Washington's Birthday. Institute closed.
March 4, Friday	Last day to drop classes without penalty.
April 1, Friday, 5 P.M. to April 11, Monday, 8 A.M.	Easter recess.
April 19, Tuesday	Patriots' Day. Institute closed.
May 30, Monday	Memorial Day. Institute closed.
May 31, Tuesday, 8 A.M. to June 10, Friday, 5 P.M.	Second semester examinations.
June 13, Monday	Commencement exercises.

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Bursar

Walter M. Drohan, A.B., A.M.
Registrar

FACULTY

Martin J. Lydon, A.B., A.M., Sc.D.
President

Charles F. Edlund, S.B., Ed.M.
Dean of Faculty

Richard W. Ivers, B.A., Ed.M.
Dean of Students

FACULTY ORGANIZATION

Lester H. Cushing, A.B., Ed.M.
Chairman

William G. Chace, Ph.B., M.S.
Vice Chairman

Charles L. Daley, B.T.C.
Secretary

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Director of Graduate School

William G. Chace, Ph.B., M.S.
Director of the Libraries

Earl J. Watt, A.B., A.M.
Assistant to Dean of Faculty

John J. MacLaughlan, Ph.B., M.A.
Director of Guidance

Arthur F. Haley, Jr., B.S., M.Ed.
Assistant Director of Admissions

Ernest P. James, B.T.C., M.S.
Director of Summer School

James W. Bell
Director of Placement

James A. McLean, B.T.E., M.B.A.
Coordinator of Special Services

A. Edwin Wells, B.T.E., M.Ed.
Coordinator of Power

Ray E. MacAusland
Chemical Stores

DIVISION OF CHEMISTRY

Elmer E. Fickett, B.S., *Professor, Chairman of Division*
Harold C. Chapin, A.B., A.M., Ph.D., *Professor Emeritus*
John H. Skinkle, S.B., M.S., *Prvfessor*
William G. Chace, Ph.B., M.S., *Associate Professor*
Ernest P. James, B.T.C., M.S., *Associate Professor*
Allen Scattergood, A.B., Ph.D., *Associate Professor*
Charles L. Daley, B.T.C., *Assistant Professor*
Charles A. Everett, B.T.C., *Assistant Professor*
Charles L. Howarth, B.T.C., *Assistant Professor*
Walter J. Lisien, B.T.C., *Assistant Professor*
Joseph H. Rosenbaum, B.T.C., M.A., Ph.D., *Assistant Professor*
Herman Brown, B.S., M.S., *Instructor*
Roland E. Derby, Jr., S.B., M.S., *Instructor* (on leave of absence)
Vasilis Lavrakas, B.S., M.S., *Instructor*
Ray E. MacAusland, *Instructor*
Robert J. Peirent, B.S., M.S., *Instructor*

DIVISION OF ENGINEERING

Herbert J. Ball, S.B., B.C.S., *Fellow of the Textile Institute* (British), *Professor, Chairman of Division, and in charge of Department of Textile Engineering*

Department of Electronic Engineering

Felix S. Palubinskas, S.B., M.A., Ph.D., *Professor, in charge of Department*

Department of Leather Engineering

Albert E. Chouinard, B.S., M.S., Ph.D., *Professor, in charge of Department*
Louis W. Stearns, B.S., A.M., *Assistant Professor*
Louis Strymish, A.B., M.ED., *Instructor*

Department of Paper Engineering

John Lewis, B.S., M.S., *Professor, in charge of Department*
Norwood H. Keeney, Jr., B.S., M.S., *Assistant Professor*
Alfred K. Hobbs, B.S., M.S., *Instructor* (on military leave)
Horace N. Lee, B.S., A.M., *Instructor*

Department of Plastic Engineering

Russell W. Ehlers, B.S., M.S., Ph.D., *Professor, in charge of Department*

Department of Textile Engineering

Herbert J. Ball, S.B., B.C.S., *Fellow of the Textile Institute* (British), *Professor, in charge of Department*
Harry C. Brown, B.S., *Professor*
A. Edwin Wells, B.T.E., M.Ed., *Professor*
Walter J. Hamburger, S.B., S.M., Ph.D., *Visiting Professor*
Maurice E. Gelinas, S.B., A.M., *Associate Professor*
Milton Hindle, B.T.E., *Associate Professor*
Henry E. Thomas, B.T.E., *Associate Professor*
J. Arthur Ainsworth, B.S., M.S., *Assistant Professor*
James W. Bell, *Assistant Professor*
Horton Brown, B.S., *Assistant Professor*
Isaac Chase, Jr., B.S., *Assistant Professor* (on military leave)
Elliot F. Humiston, Jr., S.B., *Assistant Professor*
Robert M. Kennedy, B.T.E., *Assistant Professor* (on military leave)
Andrew A. Ouellette, B.S., *Assistant Professor*
Louis C. Block, B.S., Ed.M., *Instructor*
Robert K. Devejian, B.S., *Instructor*
Philip A. Hall, B.S., M.Ed., *Instructor*
Ernest W. Lareau, B.S., *Instructor*
Kenneth L. Rogers, B.S., *Instructor*
Edward N. Sabbagh, S.B., *Instructor*

DIVISION OF GENERAL STUDIES

John R. Robertson, A.B., A.M., *Professor, Chairman of Division, and in charge of Department of Social Sciences*

Department of Air Science

Lt. Col. Walter E. Kelly, B.S., *Professor, in charge of Department*
Capt. Michael V. Hill, *Assistant Professor*
Capt. Charles M. Kyle, *Assistant Professor*
Capt. George C. Mild, *Assistant Professor*
Lt. John J. Beal, *Assistant Professor*
M/Sgt. Paul E. Blais, *Instructor*
M/Sgt. Philip L. Kennison, *Instructor*
M/Sgt. Michael J. Taylor, B.A., *Instructor*
S/Sgt. Clement W. Lake, *Instructor*

Department of Languages and Humanities

Lester H. Cushing, A.B., Ed.M., *Professor, in charge of Department*
Wentworth Williams, B.A., Ed.D., *Professor*
James G. Dow, A.B., *Associate Professor*
John J. MacLaughlan, Ph.B., M.A., *Assistant Professor*
David B. Morey, B.S., M.A., *Instructor*
Waldo W. Yarnall, B.S., *Instructor*

Department of Physical Education

Lester H. Cushing, A.B., Ed.M., *Professor, Director of Athletics*
David B. Morey, B.S., M.A., *Instructor and Coach*
Waldo W. Yarnall, B.S., *Instructor and Coach*

Department of Social Sciences

John R. Robertson, A.B., A.M., *Professor, in charge of Department*
James A. McLean, B.T.E., M.B.A., *Professor*
Stuart L. Mandell, A.B., M.B.A., *Assistant Professor*
Earl J. Watt, A.B., A.M., *Assistant Professor*
Arthur F. Haley, Jr., B.S., M.Ed., *Instructor*

DIVISION OF TEXTILE MANUFACTURING

James H. Kennedy, Jr., B.T.E., M.S., *Professor, Chairman of Division*

Department of Design, Weaving, and Knitting

Vittoria Rosatto, B.S., *Professor, in charge of Department*
Hermann H. Bachmann, *Professor Emeritus*
Russell M. Fox, *Associate Professor*
Edward L. Golec, B.S., *Associate Professor*
Nathaniel E. Jones, *Associate Professor*
John L. Merrill, B.T.E., *Associate Professor*
George G. Armstrong, Jr., *Assistant Professor*
Martin J. Hoellrich, *Assistant Professor*
Robert C. Gray, *Instructor*
Albert T. Woidzik, B.S., *Instructor*

Department of Fiber and Yarns

Chapin A. Harris, B.S., Ph.D., *Professor, in charge of Department*
Gilbert R. Merrill, B.T.E., *Professor Emeritus*
James H. Kennedy, Jr., B.T.E., M.S., *Professor*
John A. Goodwin, B.T.E., M.S., *Associate Professor*
J. Frederic Burtt, B.T.E., *Assistant Professor*
Michael J. Koroskys, B.S., M.S., *Assistant Professor*
Clarence J. Pope, B.S., M.S., *Assistant Professor*
Russell L. Brown, B.S., *Instructor*
Kenneth S. Merrill, B.S., *Instructor*

Department of Textile Finishing

John J. McDonald, B.T.C., M.S., *Associate Professor, in charge of Department*
C. Leonard Glen, *Professor Emeritus*
Winford S. Nowell, B.M.E., *Associate Professor*

Department of Textile Testing

Jacob K. Frederick, Jr., B.S., *Associate Professor, in charge of Department*
David H. Pfister, B.S., M.S., *Instructor*

OTHER OFFICERS AND ASSISTANTS

Health Services

Emile A. Houle, M.D.	*Physician*
Arlene D. Gordon, R.N.	*Resident Nurse*

Library

Joseph V. Kopycinski, B.S., M.S.	*Librarian*
Ruth A. Fitzgerald	*Library Assistant*
Shirley A. Desmond	*Library Assistant*
Robert L. Deignan	*Library Assistant*
Lorraine A. Richer	*Library Assistant*

Administrative Assistants

Helen G. Flack, S.B.	*Executive Secretary*
Theresa D. Leblanc	*Secretary, Dean of Faculty*
Elizabeth P. Kennedy	*Secretary, President*
Mona P. MacKenzie	*Secretary, Division of Chemistry*
Kleonike Bentas	*Secretary, Assistant to President*
Pauline J. Desmarais	*Secretary, Division of Manufacturing*
Eleanor M. McKenna	*Administrative Assistant*
Rita M. McKenna	*Secretary, Dean of Students*
Dorothy A. Michael	*Secretary, Division of Engineering*
Patricia E. Nickerson	*Secretary, Division of General Studies*
Maureen A. Sullivan	*Administrative Assistant*

Office of the Bursar

Wilfrid J. Brodeur	*Accountant*
Eunice M. Palmer	*Bookkeeper*
Joseph H. LeCam	*Storekeeper*

Office of the Registrar

Barbara Jean Maccaron	*Assistant to the Registrar*
Nora M. MacBrayne	*Assistant to the Registrar*

Buildings and Power

Charles A. Henry	*Chief Engineer*
Joseph A. Nerney	*Superintendent of Buildings*

ALUMNI ASSOCIATION

The active membership of the Alumni Association of the Institute is composed of graduates of the day courses and is open to any non-graduate who has satisfactorily completed at least one year of the day curriculum. Membership also includes Associate and Honorary classifications.

The Association holds its annual business meeting and banquet in the spring of each year.

Communications should be addressed to Prof. A. Edwin Wells, Executive Secretary, Alumni Office, Lowell Technological Institute.

OFFICERS AND DIRECTORS FOR THE YEAR 1953–1954

Levon M. Yacubian, '26, *President*

Alden I. Gifford, '34, *First Vice President*

G. Harry Gwinnell '25, *Second Vice President*

A. Edwin Wells, '20, *Clerk, Treasurer and Executive Secretary*

Ernest P. James, '42, *Assistant Secretary*

ALUMNI FUND COUNCIL

Evan H. Fairbanks '35, *Chairman*

BOARD OF DIRECTORS

Elected Members

Robert M. Bent '46
Kenneth B. Cook '13
William T. Dewey '34
Charles H. Forsaith '20
Kenneth R. Fox '38
Alden I. Gifford '34
G. Harry Gwinnell '25
Harold W. Leitch '14
Bryan Leonard '18
Joseph B. Masaschi '44
Philip E. Mason '26
Raymond W. McKittrick '28
Kenneth B. Park '16
David A. Travis '24
Levon M. Yacubian '26

Advisory Members

Martin J. Lydon, *President*, Lowell Technological Institute

Samuel Pinanski '12, *Chairman, Trustees*, Lowell Technological Institute

Ralph K. Hubbard '11, *Past President*, L.T.I. Alumni Association and Officers of New England, New York, Philadelphia, and Pioneer Valley (Holyoke, Mass.) Chapters

RESEARCH FOUNDATION

In recognition of the unique research opportunities afforded to industry by virtue of the equipment and staff available at Lowell Technological Institute, the Massachusetts State Legislature, in November 1950, authorized the establishment of the Lowell Technological Institute Research Foundation. Its purpose is to conduct research, development, and consulting programs under contract with responsible agencies and industrial organizations. This activity has the effect of permitting staff members access to new and significant developments in the textile and other industries and materially assists in keeping the teaching programs current and dynamic.

The Research Foundation provides the necessary mechanism whereby all of the research work of the Institute is brought under one coordinating office headed by the Executive Director. As in the past, however, the faculty of the Institute does the greater part of the research work. This plan has been proven through years of experience to be very beneficial to both the Institute and industry.

The Foundation has the use of the Institute's laboratory and research facilities in chemistry, physics, engineering, textiles, electronics, paper, leather and plastics. The Institute has many unusual research facilities. These include a completely equipped laboratory for work with radio-active materials, an Instron tester, x-ray diffraction equipment, a large spectrograph, recording spectrophotometers, a pulse-propagation meter, and a completely equipped laboratory for microscopic work including phase microscopy and electron microscopy.

It is probably the only research organization in the world having at its disposal fully equipped laboratories to manufacture and finish nearly all types of fibers by all the common manufacturing systems as well as similar equipment for paper, leather and plastics processing. These splendidly equipped laboratories serve as pilot plants for the evaluation of industrial and manufacturing problems submitted to the Foundation.

The Foundation organization is built around the three basic divisions of Research, Development, and Testing, and is currently active in all three fields for both governmental agencies and industrial organizations.

RESEARCH FOUNDATION BOARD OF DIRECTORS

Officers

Roland E. Derby, Sr., *President*
Barnett D. Gordon, *Vice President*
John H. Skinkle, *Secretary*
Homer W. Bourgeois, *Treasurer*

Executive Committee

Walter J. Hamburger, *Chairman*
Roland E. Derby, Sr.
Harold W. Leitch
Martin J. Lydon
Chapin A. Harris

Membership

Kenneth E. Bell, *Vice President and Technical Director*, A. C. Lawrence Leather Company, Peabody, Massachusetts

Homer W. Bourgeois, *President*, Union National Bank of Lowell, Lowell, Massachusetts

John J. Delmore, *Legislative Agent*, American Federation of Labor, Lowell, Massachusetts

Roland E. Derby, Sr., Textile Aniline and Chemical Company 49 Blanchard Street, Lawrence, Massachusetts

Frederick M. Feiker, National Research Council, 2101 Constitution Avenue, Washington, D.C.

Kenneth R. Fox, *Vice President*, Fabric Research Laboratories, Inc., 665 Boylston Street, Boston, Massachusetts

Barnett D. Gordon, *President*, M.K.M. Hosiery Mills, 117 Bickford Street, Jamaica Plain 30, Massachusetts

Walter J. Hamburger, *Director*, Fabric Research Laboratories, Inc., 665 Boylston Street, Boston, Massachusetts

Chapin A. Harris, *Director of Graduate School*, Lowell Technological Institute, Lowell, Massachusetts

Harold W. Knudson, *Technical Director*, Hollingsworth and Vose Company, East Walpole, Massachusetts

Harold W. Leitch, *General Superintendent in charge of Research*, Pacific Mills, Lawrence, Massachusetts

Martin J. Lydon, *President*, Lowell Technological Institute, Lowell, Massachusetts

John H. Pearson, Pearson and Pearson, 53 Central Street, Lowell, Massachusetts

Samuel Pinanski, *President*, American Theatres Corporation, 646 Washington Street, Boston 11, Massachusetts

Nathaniel McL. Sage, *Director*, Division of Industrial Cooperation, Massachusetts Institute of Technology, Cambridge, Massachusetts

Alfred J. Traverse, *Vice President*, Hub Hosiery Mills, Lowell, Massachusetts

FOUNDATION STAFF

Office of the Executive Director

John H. Skinkle, S.B., M.S.	*Executive Director*
Ann Groves	*Executive Secretary*

Fiscal Section

Richard W. Frederick, B.S.	*Business Manager*
Lorraine J. Boucher	*Bookkeeper*
Jeanne F. Molnar	*Secretary*

Development Section

George O. Langlais, B.S.	*Technical Director*
Ruth A. Jordan	*Secretary*

Research Section

Adolph Katz, B.S., S.M.	*Technical Director*
Samuel Fuller, B.T.E.	*Research Fellow*
Arthur S. Quint, S.B.	*Research Fellow*
James W. Sweeney, B.S., M.S.	*Research Fellow*
Francis Barretto	*Laboratory Technician*
Joseph Lalis	*Laboratory Technician*
John J. Lawlor, Jr.	*Laboratory Technician*
Claire F. Beaupre	*Secretary*
Mary M. Kalemaras	*Secretary*

Testing Section

Jacob K. Frederick, Jr., B.S.	*Technical Director*
Carole C. Baribeault	*Laboratory Assistant*
Helen I. Dénommée	*Laboratory Assistant*
Dorothy A. Lamoureux	*Laboratory Assistant*

Southwick Hall at Night

Alumni Memorial Library Entrance

Students Studying in Library

Lowell Technological Institute

GENERAL INFORMATION

History

The Lowell Technological Institute was incorporated in 1895 and formally opened for the teaching of textile manufacturing subjects on January 30, 1897. It was then known as the Lowell Textile School and awarded only certificates and diplomas. It grew quickly in size, prestige and scope of curricula and in 1913 was granted the right to give regular four-year degrees in textile engineering and textile chemistry.

In 1928 the name was changed to the Lowell Textile Institute to indicate more fully its collegiate status. Its continued growth resulted in further diversification of its areas of specialization and in 1950 it entered the fields of paper engineering and leather engineering. Electronic engineering was added in 1953 and plastic engineering in 1954.

In view of the present greatly expanded scope of its engineering program, its name was once more changed in 1953 to the Lowell Technological Institute. It grants the Bachelor of Science and Master of Science degrees in its five areas of specialization and is authorized to set up a program leading to the Ph.D. degree.

Since 1918, when the property of the school was transferred to the Commonwealth of Massachusetts, it has been under the control and management of a Board of Trustees appointed by the Governor.

Accreditation

The Institute is a full member in the Senior College Division of the New England Association of Colleges and Secondary Schools. The United States Department of Education and the Armed Forces consider such membership equivalent to regional accreditation. The Engineers' Council for Professional Development extends full accreditation to the curricula in Textile Engineering.

Graduates of this Institute have been accepted for Graduate School study at nearly all leading universities. The Institute's prestige in its early field of specialization, textiles, has attracted students to L.T.I. from almost every foreign country.

Coeducation

The Institute accepts both men and women for entrance providing they are properly qualified graduates of an accredited secondary school. While the great majority of its students are men, the Institute has attracted for some years a small but significant group of young women who recognize the increasing opportunities open to technically trained women in the various branches of chemistry and engineering.

Location

Lowell Technological Institute is located in Lowell, Mass., a city of 100,000, long famous as a textile center and more recently as a city of increasingly diversified industries. The campus is composed of ten main buildings located on a 15-acre site along the west bank of the Merrimack River and overlooking the rapids of Pawtucket Falls. The campus site was donated by Frederick Fanning Ayer, Esquire, and the Proprietors of the Locks and Canals on the Merrimack River.

Buildings

Southwick Hall. This was the first building erected on the present campus and was dedicated in 1903 as the gift of the Commonwealth of Massachusetts and Mr. Frederick Fanning Ayer. It is a memorial to Royal Southwick, an ancestor of Mr. Ayer and a leading textile manufacturer and public figure of his day. It contains the gymnasium, assembly hall, chemistry division and administrative offices.

Kitson Hall. Completed in 1903, Kitson Hall houses the cotton yarn, knitting, mechanical and electrical laboratories. It was erected by Charlotte P. Kitson and Emma K. Stott as a memorial to their father, Richard Kitson, founder of the Kitson Machine Company of Lowell.

Falmouth Street Building. Erected in 1903 as a one-story building, it was enlarged to its present capacity in 1907 by the Commonwealth of Massachusetts. Power weaving, woolen and worsted yarn, and filament yarn laboratories, as well as class rooms, occupy this section of the original quadrangle.

Louis Pasteur Hall. Originally constructed as a one-story building it was enlarged to four stories in 1937 by the Commonwealth of Massachusetts. Most of the main chemistry laboratories, cotton finishing, textile testing and special research laboratories are contained in this area. It also houses the national research laboratories of the American Association of Textile Chemists and Colorists as well as the L.T.I. Research Foundation laboratories.

Paper and Leather Building. Completed in 1952 by the Commonwealth of Massachusetts, this modern building houses complete leather and paper manufacturing facilities, advanced textile testing and electronic laboratories, as well as many modern lecture rooms.

Alumni Memorial Library. Erected in 1951 by the Alumni Association through contributions from alumni and friends of the Institute, this modern library is dedicated to the men and women of the Institute who served this nation in World Wars I and II and the Korean conflict.

Besides a book stack capacity of 80,000 volumes, it contains student activity offices, alumni offices, reading rooms, typing facilities, microfilm room and faculty studies. It houses one of the most complete collections of textile books in the world and numerous special collections.

Administration-Auditorium Building. Completed in 1954, this building provides a 1200-seat auditorium for academic convocations and social activities. It also contains the main administrative offices including that of the President and Deans. Much of the basement is devoted to the L.T.I. Research Foundation laboratories.

Smith Hall. Erected in 1948 by the Lowell Textile Institute Building Association, Smith Hall has living accommodations for 112 students. The basement contains the college cafeteria and a medical dispensary. It is dedicated in honor of James T. Smith, pioneer educator in the textile field and the individual primarily responsible for the organization of the Lowell Textile School in 1895.

Eames Hall. The second men's residence hall was completed in 1949 by the Lowell Textile Institute Building Association and contains living quarters for 112 students, a student lounge and recreation center, and a snack bar. It is dedicated in honor of Charles H. Eames, President of the Institute from 1905 to 1945.

Equipment

The total value of the scientific and industrial equipment used in the instructional and research program of the Institute is approximately five million dollars. This equipment ranges from the most delicate scientific instruments, such as the electron microscope, to full-sized industrial machines.

The textile manufacturing equipment includes a full line of machines for processing any fiber, whether natural or man-made, on the cotton, woolen, French worsted, English worsted or American worsted system. It also includes a modern throwing plant for filament yarns and a garnetting unit to reclaim used fibers.

All types of modern looms and knitting machines together with a full line of wet and dry finishing equipment enable the Institute to manufacture, under almost all industrial conditions, any type of fabric and finish desired.

The textile testing laboratories are among the most completely equipped in the world and have the use of the extensive optical and electronic facilities used in advanced research work.

In the completely equipped paper and leather laboratories both leather and paper of nearly all grades and types can be fully processed from raw materials, finished, and tested by the most modern methods.

The wide variety of electronic equipment already available is in the process of being greatly augmented and consolidated in the new expanded electronics laboratories. The new plastics fabricating laboratories will be in operation by the spring of 1955 and will represent one of the few complete plastics laboratories in the country.

Complete mechanical, electrical and chemical laboratories of the usual types round out the unusual variety of equipment available for instruction and research.

ADMISSION OF UNDERGRADUATES

New students at the Lowell Technological Institute are selected from those applicants who, during their preparatory education, have shown evidences of promise in scholastic ability, strength of character, and leadership. In addition to scholastic rating and test results a high value is put on evidences of leadership and contributions to school and community life.

Application Procedure

Formal application for admission should be made as early as possible in the candidate's senior year of secondary school. Students from foreign countries are strongly advised to begin admission procedures not less than twelve months in advance of the expected date of enrollment.

Preliminary correspondence before the senior year is welcome and frequently helpful to the student in planning his secondary-school program to fit the needs of his freshman year at the Institute.

Requests for application blanks and all correspondence relating to matriculation at the Institute should be addressed to the Director of Admissions.

Steps to be taken for admission are:

1. Pages one and two of the admission application form should be completed by the candidate.

2. Attach a certified check or money order in payment of the application fee of $10. (See "Student Expenses" for explanation.)

3. The whole application form should then be submitted to the office of the candidate's secondary-school principal, with the request that his office fill out pages three and four and mail the completed application directly to the Director of Admissions.

It is recommended that this procedure be accomplished as soon as possible in the candidate's senior year in secondary school so that he may be considered for admittance to classes beginning the next September.

4. All candidates for scholarships should make direct application to the College Entrance Examination Board, P. O. Box 592, Princeton, New Jersey, with a request to take the Scholastic Aptitude Test, described below under the heading *Requirements*.

5. Each applicant must submit to a complete health examination by his family physician. A certificate of good health, indicating the date of this examination, must then be sent by the physician to the Director of Admissions. The Institute has prepared a special form for the convenience of the physician; a copy of this certificate of health will be supplied.

6. A personal interview with the Director of Admissions is strongly recommended. The Office of Admissions at the Institute is open for

this purpose Monday through Friday, from 8:30 A.M. to 4:00 P.M. during the school year. *It is urged that appointments for an interview be made in advance.*

Requirements

Fulfillment of prescribed requirements does not automatically constitute the acceptance of a candidate. The final decision as to the eligibility of an applicant shall be left to the discretion of the Institute.

The conditions under which an applicant may be accepted are as follows:

1. A candidate for admission must be a graduate of a secondary school approved by the New England Entrance Certificate Board, the Regents of the State of New York, or a Board of equal standing.

2. (a) Because of the specialized nature of the various curricula at Lowell Technological Institute, it has been deemed advisable that all entering students shall have completed the following units of secondary-school study:

Algebra (quadratics and beyond)	2 units
Plane Geometry	1 unit
English	4 units
American History	1 unit
Chemistry (including laboratory)	1 unit
or	
Physics (including laboratory)	1 unit

Preference will be given to applicants offering both chemistry and physics. In addition to the above-listed prerequisites, each applicant must offer credit in elective subjects, such as: languages, other than English; history, other than American; mechanical drawing; solid geometry; advanced algebra; scientific subjects; social studies, and others. Trigonometry is recommended but not required.

(b) The combined prerequisites and electives should total at least 15½ Carnegie units. Each such unit of preparatory credit is the equivalent of one secondary-school subject satisfactorily pursued during one academic year of at least thirty-six weeks of four forty-minute meetings each week, or the equivalent.

(c) In evaluating the credits offered by an applicant for admission, the Institute will be guided primarily by the quality of his scholastic record and by his apparent promise on grounds of intellect and character. Therefore, an applicant whose preparation has not followed the normal pattern with respect to the accumulation of unit credits should not hesitate to apply for entrance, provided that the quality of his scholarship gives evidence of ability to do college work and provided that he is recommended by his school. (For additional information, see paragraph "Exceptions to Admission Rule" below.)

3. All candidates for admission who are also applying for a scholarship must complete the Scholastic Aptitude Test which is prepared, administered, and graded independently of Lowell Technological Institute. Application to take the test must be made directly to the College Entrance Examination Board, P. O. Box 592, Princeton, New Jersey. Arrangements to take the test, which is scheduled annually for the early part of March, should be completed as early as possible in the candidate's senior year in secondary school.

Exceptions to Admission Rules—In special cases, at the discretion of the Institute, applications may be accepted from candidates in the following categories:

1. Applicants who lack credit in specified required subjects because they are not offered in the course of study at their secondary school. Such applications will be considered only when the quality of work done in other departments is exceptionally high.

2. Applicants who offer credit in all the required subjects, but whose accumulation of unit credits does not total 15½. Very few students will find themselves in this category, because most secondary schools require at least 15½ units for graduation. However, the Institute is willing to recognize the possibility that a student, well-qualified in all other respects, should not be denied the opportunity to submit his application because of purely quantitative considerations.

3. Applicants who have not maintained a uniformly good scholastic average in all subjects but are otherwise acceptable may be required to pass certain tests given by the Guidance Department of Lowell Technological Institute.

Admission With Advanced Standing

Transfer students must submit transcripts of their college record, a copy of their college catalogue and letters of honorable dismissal well in advance of their planned transfer date. The Director of Admissions and Department Heads concerned will gladly advise prospective applicants of advanced standing concerning their plan of study and other matters concerned with advanced standing.

Transfer credit will be given for courses satisfactorily completed that are the equivalent in quality and scope of those given at the Institute. Final decision on transfer credit rests with the Divisional Chairman in charge of the subject for which transfer credit is desired.

Special Students

Qualified applicants may be accepted for specialized work not leading to a degree. The plan of study should have a clearly defined objective and should not deviate markedly from the regularly formulated subject matter and laboratory courses at the Institute. Admission as a special student is contingent upon approval by the Director of Admissions and the Divisional Chairmen concerned in the proposed program.

Foreign Students

Each year Lowell Technological Institute accepts for admission foreign applicants up to 5% of the total number of students in any given class (freshman, sophomore, etc.). There are no special procedures to be observed by foreign candidates, although it is urged that they endeavor to have the transcript of their secondary-school and/or college records, as well as all other admission materials submitted, in English, *not less than twelve months in advance of the expected date of enrollment.* All applicants should have a considerable facility in speaking and writing English, and have financial resources sufficient at least for their first year of study. Foreign students will be expected to complete the same schedule of courses as is assigned to all other students.

In all respects, the admission procedures for foreign students are identical with those required of U. S. citizens.

To facilitate their adjustment to the life of the campus, undergraduate foreign students are regularly assigned room space, shared jointly with American students, in the residence halls of the Institute. Graduate students spend at least their first year at the Institute in a residence hall room. Students attending for the first time should note that towels, sheets, pillowcases, and blankets must be supplied by occupants of rooms. Students are therefore reminded that bedding, as well as clothing, should be suitable for a climate in which temperatures normally fall well below the freezing point during the winter months.

STUDENT HOUSING AND SERVICES

Residence Halls

All male students are required to live in the residence halls unless excused in writing by the Dean of Students. While such excuses are normally granted for the academic year, they are subject to review at the beginning of each semester and may be cancelled should conditions require.

Application for permission to occupy other living quarters will be made on special blanks available at the Dean of Student's Office. An application must be filed annually by each student. Deadlines for filing applications are: (a) for all new students (incoming freshmen, transfer students, special students, or graduate students)—on or before September 1 of each year; (b) for all regularly enrolled students—on or before June 1 of each year.

In granting special permission, the Dean of Students will give full consideration to the following:

a. Distance from Institute to place of legal residence.

b. Financial hardships involved in living in residence hall.

c. Year of the student (freshman, sophomore, junior, senior, graduate).

d. Membership in fraternities that maintain a fraternity house.

Rooms are furnished by the Institute but are cared for by the students occupying them. Sheets, pillowcases, blankets, towels, and other personal linens must be supplied by each student. Each occupant is held responsible for any damage done to furniture and equipment.

Assignments of rooms in the residence halls are made through the Office of the Dean of Students. All assignments are for the full academic year. Change of room is not permitted except under unusual circumstances, and may be accomplished only after a formal application has been approved by the Dean of Students.

All rentals are uniform, the annual charge being $275.00 per academic year for each student. While this charge covers occupancy during periods that the Institute is regularly in session, it may, at the option of the Institute, be extended to vacation periods.

Assignments of rooms are made as equitably as possible and in the order that applications are received. For those students who are unable to be placed in residence halls, the Dean's Office supplies a list of approved rooming houses where students may reside.

Dining Hall

Dining facilities are provided on the campus with a cafeteria located on the ground floor of Smith Hall and a snack bar located in the Students' Lounge in Eames Hall. These facilities provide additional opportunities for the students to become better acquainted as well as assuring wholesome food and a balanced diet.

Guidance

A committee of faculty members supervises a guidance program which begins with the admission procedures, continues throughout the undergraduate years, and culminates in the work of the Placement Office.

Guidance in the freshman year stems mainly from the results of the diagnostic testing program, Freshman Week activities, the Effective Study Course and the work of the Faculty advisers. These advisers function throughout the freshman year. During the sophomore, junior and senior years the heads of departments and the Dean of Students take over the primary responsibility for the students' personal and scholastic guidance.

The Office of the Dean of Students is open to all undergraduates at all times to assist the student in attaining his academic objective, and to assure his active, enjoyable participation in the work and affairs of the Institute.

The Placement Office functions as a natural outgrowth of the undergraduate guidance program. This office endeavors to keep Institute undergraduates and graduates in constant contact with the latest developments in the industry, so that they may place themselves in positions best suited to their talents and abilities.

Health Service

The Dispensary, in Smith Hall, is in charge of a registered nurse eight hours each school day. She is on call 24 hours daily, including week ends. Students receive first-aid treatment at the Dispensary, and are advised as to the best procedures in case of illness.

The college physician is on call 24 hours daily. If any student requires hospitalization, the college physician will arrange for admission to one of the three excellent, modern hospitals located in the immediate vicinity of the Institute. Medical fees and hospital charges are at the expense of the student.

Accident insurance during the academic year is compulsory and is included in the Activity and Insurance Fee. Sickness insurance is also available on a voluntary basis through the Office of the Dean of Students.

STUDENT REGULATIONS

Conduct

Students admitted to Lowell Technological Institute are assumed to be ladies and gentlemen, and of sufficient maturity and poise to enable them to live in an adult environment. Such living involves full respect for the rights of others, a regard for self-discipline and good order, and a high standard of honesty and of moral conduct.

In consequence of these assumptions, the regulations are framed not to restrict the conduct of individuals or groups of students, but, rather, to set forth the basic policies of the Faculty established in order that a large student body may live and work harmoniously together with a minimum of friction and misunderstanding. By the same token, even though the rules are neither detailed nor comprehensive, a student may be dropped from the rolls, or subjected to other disciplinary action, for conduct which is illegal, immoral, or inimical to the best interests of the Institute, regardless of whether or not the particular offense is listed in these rules and regulations.

Attendance

Attendance is expected of all students at all classes. The supervision of student attendance is lodged in the Office of the Dean of Students, both as to the announcement of detailed instructions and as to the enforcement of the rules established by the Faculty. Students charged with unexcused absences, particularly absences immediately before and after holiday and vacation periods, are subject to disciplinary action.

Disciplinary Action

Disciplinary action originates in the Office of the Dean of Students. Such action may be in the form of any of the following degrees of severity: Censure, Restriction, Suspension, or Dismissal. Whenever disciplinary action is taken, a notation of such action becomes a part of the permanent record of the student.

Academic Grades

The students' grades are reported by letter as follows:

A	90–100	F	Below 60, Failure
B	80–89	I	Incomplete
C	70–79	W	Withdrawn
D	60–69	X	Dropped

The student's semester rating is a weighted value used to denote his relative standing. The point values assigned are A = 4 points, B = 3 points, C = 2 points, D = 1 point and F = 0 points. These point values, when multiplied by the credit hours assigned to the subject and added together, are divided by the sum of the credit hours, to give the student's semester rating. The cumulative rating for more than one semester will be obtained in the same manner as the computation for the rating of a single semester.

Scholastic Reports

Reports of scholastic standing are compiled regularly at the end of each semester and formal notification of each student's status is made at that time.

Dean's List

The Dean's List is composed of those students who have a semester rating of 3.00 or higher, with no current failures.

Probation

A student is placed on probation when his semester rating is below 1.25. The probationary period covers the entire semester following the issuance of the semester rating which placed the student on probation.

A student with a rating of less than 1.25 for two consecutive semesters may be dropped from the Institute for at least one semester.

A student on probation may not represent the Institute in any public function and may not hold class or other offices during his term of probation.

If a student receives a semester rating below 0.50, he may be automatically dropped from the Institute without benefit of a probationary period.

REQUIREMENTS FOR GRADUATION

Only those students who have satisfied the following minimum requirements will be recommended for the baccalaureate:

(1) Complete successfully one of the prescribed curricula with no substitutions for major subjects therein and no unremoved failures in a major subject.

(2) Earn a cumulative rating of 1.5 or better for the entire period at the Institute.

(3) Pass 80% of the credit hours offered towards the degree with grades higher than D.

Graduation Honors

Academic honors are awarded at the annual Commencement Exercises by appropriate notation on the diploma for the baccalaureate

degree, and by printing in the commencement program the names of students who have earned such recognition. Honors are awarded according to the following standards of achievement:

a. Any student who graduates with a rating of 3.00 — 3.49 for the entire period of study at the Institute shall be awarded the baccalaureate degree "*With Honors*".

b. Any student who graduates with a rating of 3.5 or better for the entire period of study at the Institute, shall be awarded the baccalaureate degree "*With High Honors*".

c. The highest ranking student in each graduating class who graduates with a rating of 3.8 or better, and who has completed at least six semesters of work at the Institute, shall be awarded the baccalaureate degree "*With Highest Honors*".

STUDENT AWARDS

The following awards are made annually:

(1) *American Association of Textile Chemists and Colorists Book Prize*

Awarded to the outstanding graduating senior in the course of Textile Chemistry. The recipient is selected by the Chemistry Division and the academic standing of the candidate is an important factor. The award includes a junior membership for one year in the A.A.T.C.C.

(2) *American Association for Textile Technology Award*

Given annually to the member of the senior class, majoring in textiles, who is rated highest on the basis of scholarship, technical ability, industry, judgment, leadership, reliability, and ability to work with others.

(3) *National Association of Cotton Manufacturers Award*

Given to the member of the graduating class in Textile Engineering (General Manufacturing Option) or Textile Manufacturing who has maintained the highest scholastic standing throughout the four years of his undergraduate work.

(4) *Phi Psi Award*

Given annually to an outstanding member of the graduating class in a Textile course on the basis of scholastic standing, leadership, initiative, personality, loyalty, and courtesy.

(5) *Louis A. Olney Book Prizes*

Selected reference books are awarded annually to the outstanding freshman, sophomore, and junior students in the course of Textile Chemistry. The recipients are selected by the Chemistry Division chiefly on the basis of academic standing in chemical subjects.

(6) *Chemistry Department Award*

A book prize is awarded to the member of the freshman class who shows the highest achievement in Freshman Chemistry during the first semester.

STUDENT EXPENSES

The various student expenses described in this section apply only to the regular day school of Lowell Technological Institute. The fees and expenses of the Evening Division are described in a separate bulletin. All fees are established by the Board of Trustees and are subject to change without advance notice.

Payment of tuition and fees is an integral part of the registration process which must be completed before a student may attend classes. In special cases a delay in the payment of fees may be authorized, but all fees *must be paid* on or before the close of the sixth week of classes of the semester involved. Requests for delay must be approved *before* a student's registration is complete.

Application Fee (first year of registration only) $10

Payable by certified check or money order and filed with the Director of Admissions at the time of application.

a. If the applicant is accepted for admission and is duly enrolled as a student at the Institute, the entire amount of this fee shall be credited toward his tuition charges on the day of registration.

b. If the applicant is not accepted for admission as a student, the entire amount of this fee shall be refunded.

c. If the applicant is accepted for admission but does not choose to enroll as a student, no refund shall be made.

d. If the applicant is accepted for admission but is called to duty in the Armed Services of the United States, he shall, upon presentation of suitable evidence of this fact, be entitled to a refund of the entire amount of the application fee.

Tuition—The yearly tuition fees are:

Residents of the Commonwealth of Massachusetts	$150
Non-residents	$250
Foreign students	$500

Students who are classified by the United States Immigration Authorities as "Displaced Persons" will pay non-residents' tuition of $250.

Special students pay, in general, the full tuition fee. However, if enrolled in only a limited number of courses, a special student may make application to the President for a reduction in tuition.

Residence

Because Lowell Technological Institute is a state-supported institution, its educational program and facilities are made available at a low tuition rate to students entering from the Commonwealth. Eligibility for admission as a resident entitled to the low residential tuition is determined under policies established by the Board of Trustees.

a. Every student claiming residence in Massachusetts must file with the Bursar a certificate signed by either the town or city clerk of the community claimed as legal residence, stating that the student's parents, or guardian, are legal residents of the Commonwealth of Massachusetts.

b. The residence of a minor shall follow that of the parents, unless the minor has been emancipated. A minor student who has been emancipated shall, in addition to the requirements respecting residence, present satisfactory documentary evidence of emancipation.

c. A minor under guardianship shall be required to present satisfactory documentary evidence of the appointment of a guardian in addition to the certificate of residence of the guardian.

d. A student shall not be considered to have gained residence in the Commonwealth of Massachusetts by reason of attendance at Lowell Technological Institute, nor shall a student lose residential preference during continuous attendance at the Institute.

e. The residence of a wife shall follow that of the husband.

f. The prescribed form of application for classification as to residence shall be executed for each student. Misrepresentation of facts to evade payment of the proper rate of tuition shall constitute sufficient cause for suspension or permanent separation from the Institute.

g. Payment of one-half of the total yearly tuition will be made during the registration for each semester.

h. The President of the Institute is authorized to adjust individual cases within the spirit of these rules.

ROTC Deposit $25

This deposit covers loss of, or damage to, uniform or equipment used for ROTC instruction. Required of all students enrolled in ROTC. The entire amount, less charges, will be refunded upon the completion of the ROTC requirements. If, at any time, the charges against a student exceed the amount on deposit, the student will be required to pay such charges and to make an additional deposit of $25.

Note: Wherever mentioned above, the word *residence* is considered to mean *legal domicile.*

Activity and Insurance Fee $40

Each student will pay $20 each semester of the academic year as a student activity and insurance fee. The payment of this fee entitles the student to free admission to all athletic events, a mailbox in the campus post office, a subscription to the student newspaper, and a copy of the yearbook. A portion of this fee helps to support the general student activities under the jurisdiction of the Student Council. It pays for the compulsory accident insurance policy which covers each student against accidents during the academic year and also contains a compulsory bonding fee which protects the Institute against unpaid student charges.

Residence Halls $275

All students, except those who live in Lowell or the surrounding community, may be required to live in one of the residence halls (see page 24 for details). The double rooms rent for $275 per student per year. One-half of the rent ($137.50) is payable at the start of each semester.

Laboratory and Materials Fee

To cover the cost of materials and normal breakage in all laboratories, each student will be charged as follows:

All freshmen	$12/semester
Upperclassmen enrolled in:	
(a) Textile Manufacturing (including Courses I, II, III, and V), Textile Engineering, Textile Sales, or Electronic Engineering	$12/semester
(b) Paper, Leather, or Plastic Engineering .	$17/semester
(c) Textile Chemistry	$22/semester

The above charges are not refundable. Excess breakage will be billed direct to the student. These fees are payable each semester regardless of the number of laboratories taken and represent an average flat charge per semester for the regular four-year program in each of the above courses.

The above fee must be paid before a student can be admitted to laboratory work.

Commencement Fee $15

Covers commencement expenses such as diploma and case, rental of cap and gown, ten invitations per student, printing and other incidentals.

Late Registration Fee $5

Any student who does not complete his registration (including the payment of all fees) by the close of the registration period stated in the Institute calendar may be required to pay an additional fee of $5.00.

Official Transcript Fee $1/copy

Each student will be allowed free of charge a total of three transcripts of his scholastic record. A charge of $1.00 per copy will be made for each *additional* transcript.

Auditing Fee . . . . $5/credit hour

All students regularly enrolled and paying the full tuition charge in any semester may audit courses in that semester without charge providing proper approval is obtained.

Students not regularly enrolled or not paying the full tuition charge for the semester must pay $5 per credit hour to audit a course and must obtain proper approval.

Books and Materials—Students must provide their own books, stationery, tools, etc., and pay for any breakage or damage that they cause to machines, laboratory equipment, and other property of Lowell Technological Institute.

All raw stock and yarn furnished to the students, and all the productions of the Institute, remain or become its property, except by special arrangement, but each student is allowed to retain specimens of yarn or fabrics that he has produced, if mounted and tabulated in accordance with the requirements of the department. It is understood that the departments may retain such specimens of students' work as they may determine.

No books, instruments, or other property of the Institute loaned to the students are to be removed from the premises except by special permission.

Refund Schedule—Applications for refunds, filed with the Bursar on withdrawal, will be made in accordance with the following table:

No. of Weeks		*Refund*
At least	*But less than*	*Rate*
0	2	80%
2	3	60%
3	4	40%
4	5	20%
5 and over		None

Summary of Expenses Per Year

Tuition (residents of Massachusetts)	$150
Tuition (residents of other states)	250
Tuition (residents of other countries)	500
Dormitory rate per year	275

Laboratory and Materials Fee	
(a) All freshmen	24
(b) Upperclassmen enrolled in:	
Textile Manufacturing (including Courses I, II, III, and V), Textile Engineering, Textile Sales, or Electronic Engineering	24
Paper, Leather, or Plastic Engineering	34
Textile Chemistry	44
Student Activity and Insurance Fee	40
ROTC Deposit	25
*Books and supplies	50
Commencement Fee	15
Late Registration Fee	5
Official Transcript Fee	1

*Books and supplies for the first year cost about $80, second and third year $35. and fourth year $50, thus averaging about $50 per year for the four years,

STUDENT ACTIVITIES

Lowell Technological Institute believes that sound educational practice seeks to develop the whole personality of the student. Accordingly, Faculty and Administration encourage extra curricular activities and support the development of a varied and well-rounded program of activities to supplement the purely academic phase of undergraduate life. This program provides opportunity for participation in formal and informal sports, in class and campus self-government, and in the many clubs and special interest activities which appeal to the varied interests of the student body.

Student Council

The Student Council is the chief body for the conduct of self-government in student affairs. It is composed of four officers elected at large by the student body, the president of each undergraduate class, and one representative from each of the classes.

By virtue of its function as chief governing body for student affairs, it exercises administrative control over all campus organizations formed under its supervision; represents the student body in matters requiring conference with the Administration and Faculty; investigates grievances submitted by students or student groups; sponsors all-campus dances, banquets, and other social affairs; and supervises the expenditure of the unallocated portion of the Student Activity Fee. It functions in accordance with the specific prescriptions of its Constitution and By-Laws.

Arnold Air Society

The Air Force Association sponsors this military fraternity at all colleges that have an AFROTC program. The purpose of the Arnold Air Society is to unite selected Advanced AFROTC Cadets by a fraternal bond in support of a common cause—the Air Age. A chapter of this society has been established at this Institute. The Arnold Air Society is responsible for a cadet sports program and a variety of social affairs during the academic year, culminating in a military week end which features a colorful drill ceremony and has as its climax the formal Military Ball. One of the outstanding events of the Military Ball is the naming of the Honorary Cadet Officers.

Athletics

The Athletic Association promotes an extensive varsity and intramural sports program. All students are members of the Athletic Association and receive free admission to all intercollegiate contests played at home.

Pickout Staff

Big Weekend Ahead

Flying Club

Students in Residence Hall

Soccer, Basketball and Baseball are varsity sports at the Institute. Competition is chiefly with teams in the northeast portion of the country. Lacrosse, Golf, Tennis and Ski Teams also compete regularly with other colleges in the area.

Intramural sports are sponsored by the Director of Intramural Athletics with an interesting year-long program of both league and informal competition between the classes, residence halls and fraternities.

Band

The AFROTC Band is composed primarily of cadets who are musicians or who desire to learn to play a band instrument. In addition to providing the music for the AFROTC ceremonies, the band adds considerably to the color and life of the campus by participating in various Institute and civic programs.

Circle K

The Circle K club is the student chapter of the Kiwanis at the Institute. In addition to performing many services in the public interest, they assist the administration of the Institute in running the freshman orientation program each year.

Flying Club

Membership in the club is open to all students. The club maintains an airplane for the use of the members. Flying lessons may be taken, and all AFROTC members who solo will be awarded AFROTC wings.

Fraternities

The Interfraternity Council fosters the common interests of the four fraternity chapters at the Institute. This organization sponsors joint social and athletic contests among the fraternities.

The four fraternities have their own houses for fraternity socials and meetings, providing centers for the social life off the campus. The fraternities are: Delta Kappa Phi, Omicron Pi, Phi Psi, and Pi Lambda Phi.

International Students Club

This club lists all foreign students at the Institute as its members. It serves to bring into close contact all these students who may have some difficulty in becoming adjusted to a new language or way of living. These students are in demand by local civic groups to serve as speakers on many programs.

The Nucleus

The club was initiated to serve as a focal point for students to meet and present ideas and reports regarding actual activities in industry. The club has a membership limit of 15 members who are the leaders of all the major activities on the campus. A high scholastic rating is also a prime requisite for active participation.

"Pickout"

The "Pickout" is the annual year book of the campus. Those who serve on the staff secure a valuable training in the editorial, art, and business problems involved in the production of a top-quality photo-literary history of the academic year.

Professional Societies

The following societies conduct monthly meetings at which students and outstanding speakers present technical papers and lectures. Frequent field trips to industrial plants are also made by the members. These societies include:

(1) American Association of Textile Chemists and Colorists
(2) Engineering Society
(3) Leather Engineering Society
(4) Paper Engineering Society

Radio Station

The Radio Station (WLTI) is an all-student enterprise built and maintained by members of the Lowell Technological Institute Broadcasting Society. Programs are transmitted by a carrier current to the buildings of the campus from the station studio.

The radio station sells air time to local merchants and thus is a self-supporting organization. It provides a fine opportunity for students to learn business practices as well as broadcasting and radio techniques.

Religious Groups

Hillel. The Hillel Counsellorship was established to provide social, cultural and religious programs for the Jewish students at the Institute. Discussion groups are held weekly and brunches or dances monthly. Speakers are invited to talk on subjects of interest to the whole student body. Hillel groups, located at most of the larger colleges and universities, are sponsored by the national B'nai B'rith organization.

Iona. A group composed of students and faculty members of various races and creeds who, by uniting in a common fellowship, attempt to understand the will of God through worship, study and action, and thus realize it both in personal living and in working toward a better society.

Newman Club. The Newman Club is an organization sponsored by the Catholic students at the Institute. It conducts joint monthly meetings with the Lowell State Teachers College Newman Club.

Rifle Team

The AFROTC Rifle Team is a member of the National Rifle Association and the New England College Rifle League. In addition to competing in a full schedule of intercollegiate rifle matches, the

team competes each year against all of the AFROTC units in the First Air Force for the FIRST AIR FORCE TROPHY and all of the AFROTC units in the nation for the WILLIAM RANDOLPH HEARST TROPHY.

Scholastic Honor Society

Membership in Tau Epsilon Sigma is open to members of the Junior and Senior Classes who are elected on the basis of outstanding scholastic achievement.

Sorority

The Sorority Phi Sigma Rho provides a center for the social life and association of the young women enrolled in the various programs of the Institute.

Tech Players

All the theatrical activities of the Institute are centered around the Tech Players. For years the annual production of this group has been a high point in the social calendar.

"The Text"

"The Text" is the campus newspaper. Prepared and edited by the students, this bi-weekly publication offers excellent journalistic and business experience to those who work on its staff.

Varsity Club

This club is composed of students who have earned letters in any of the six intercollegiate sports, namely, Baseball, Basketball, Golf, Lacrosse, Soccer and Tennis. Its purpose is to help athletes academically and to foster a lasting friendship among the men participating in athletics.

FINANCIAL AID TO STUDENTS

SCHOLARSHIPS

A large number of scholarships are available to students and prospective students of Lowell Technological Institute through funds contributed by various trusts, organizations, civic bodies and industrial firms. Many of the scholarships are renewable yearly for the balance of the student's undergraduate program, providing a satisfactory scholastic average is maintained; others are only for a specified period of time.

Unless otherwise specified, application for all scholarships should be made to the Dean of Students.

Available for Freshmen and Upperclassmen

1. Alumni Association Scholarships—Lowell Technological Institute

   Scholarship funds under the care of the Alumni Association make available several scholarships a year which cover tuition and miscellaneous fees. These scholarships are renewable if a satisfactory scholastic standing is maintained.

2. Berkshire Fine Spinning Associates, Inc. Scholarship

   A number of scholarships covering tuition and living expenses for four years are offered in Textile Engineering and Manufacturing by the Berkshire Fine Spinning Associates, Inc., Providence, Rhode Island. Eligible applicants are:

   a. Male employees of Berkshire Fine Spinning Associates, Inc. who have had adequate secondary school training.

   b. High School graduates who are sons of present employees.

   Interested students should contact the Berkshire Fine Spinning Associates, Inc., Turks Head Building, Providence 1, Rhode Island.

3. Russell L. Brown Scholarship—Donated by Davis and Furber Machine Company.

   This scholarship is open to a student acceptable to Lowell Technological Institute who plans to enroll in the curriculum of Textile Engineering or Textile Manufacturing. Preference is given to employees and sons or grandsons of employees of Davis and Furber Machine Company. The selection is based on general scholarship, initiative, and need. The stipend is $300. The appointments are for one year only but are renewable.

Baseball

Basketball

Soccer

Lacrosse

4. Caron Spinning Company Scholarship

This scholarship is awarded to employees or to relatives of employees of the Caron Spinning Company and to graduates of Rochelle, Illinois High School, on the basis of general scholarship, initiative, and character. The amount of the scholarship is $1250 each year, and it is awarded on a four-year basis provided satisfactory academic standing is maintained. Application should be made directly to Caron Spinning Company, Rochelle, Illinois.

5. Goodall-Sanford, Inc. Scholarship

Goodall-Sanford, Inc., Sanford, Maine, offers to eligible employees of the company full four-year scholarships, the recipient to receive income at the rate enjoyed by the candidate while in the employ of the company. Successful candidates may choose any textile school certified by Goodall-Sanford, Inc., Lowell Technological Institute being one of these approved schools.

Application should be made to Goodall-Sanford, Inc., Scholarship Committee, Sanford, Maine.

6. Leather Engineering Department Scholarships

The Leather Engineering Department has funds under its jurisdiction which it periodically releases for scholastic aid purposes through the Institute Scholarship Committee. These funds have been made available by interested industrial firms and trade organizations. These scholarships are available to deserving students enrolled in the Leather Engineering course who need financial assistance for scholastic purposes.

7. City of Lowell Scholarships

The City of Lowell has appropriated funds to provide a total of five scholarships every two-year period. Three scholarships were awarded during the 1953–1954 academic year and two scholarships are to be awarded during the 1954-1955 academic year. These scholarships are to be awarded on the basis of competitive examinations to residents of the City of Lowell, Massachusetts who are enrolled in the freshman class at the Institute. The amount of the scholarship is $150, which is full tuition at the Institute, and is renewable providing satisfactory scholastic grades are maintained.

8. Commonwealth of Massachusetts Scholarships

Ten scholarships of $250 each year are available for young men and women who are residents of the Commonwealth of Massachusetts and are enrolled in the freshman class at the Institute. Awards are made on the basis of competititve examinations and the scholarships are renewable providing satisfactory grades are maintained.

9. The McLaurin-Jones Company Scholarship

This scholarship is awarded annually to a member of the Brookfield or Ware High School graduating class or to an employee of the McLaurin-Jones Company for work in the Paper Engineering Department. The scholarship for $500 is renewable from year to year for four years if a satisfactory scholastic record is maintained.

10. Mohawk Carpet Mills Textile Scholarship

A $2,000 scholarship has been made available to high school graduates or employees of the Mohawk Carpet Mills who are residents of New York State. All applicants must have applied for enrollment in one of the various textile courses at the Institute in order to be eligible. Application must be made to the Mohawk Carpet Mills, Inc., Amsterdam, New York.

11. New England Tanners Club Scholarship

This scholarship is awarded by annual vote of the New England Tanners Club and is granted to a student in Leather Engineering at Lowell Technological Institute. Preference is given to employees of the member companies of the New England Tanners Club or to their families. If no eligible applicants are available, awards will be open to others on the basis of secondary-school scholastic performance and evidence of potential leadership. The amount of the scholarship is $500, awarded on a one-year basis.

12. New England Textile Foundation Undergraduate Scholarships

Scholarships of $500 per year are available by means of competitive examinations to students who qualify for entrance to Lowell Technological Institute under the terms described in the ADMISSION OF UNDERGRADUATES section of this Bulletin. These scholarships are for one year but are renewable providing a satisfactory scholastic standing is maintained. All students interested in competing for one of these awards should make application directly to the New England Textile Foundation, 31 Canal Street, Providence, Rhode Island no later than January 15. Detailed instructions and the necessary application forms will be sent to each applicant accepted for the competition.

13. Pacific Mills Worsted Division Overseers Association Scholarships

Several $150 scholarships for freshmen only are supported by the Overseers Association of the Pacific Mills Worsted Division, Lawrence, Massachusetts. The Overseers Association selects qualified candidates, who must then meet with the approval of the Institute.

14. Paper Engineering Department Scholarship

A scholarship prize of $100 is awarded at the beginning of the spring semester to the member of the freshman class who achieves the highest scholastic standing. This prize is made available by a number of interested companies for students enrolled in the Paper Engineering Department.

15. Sylvan I. Stroock Scholarship—S. Stroock & Co., Inc.

Awards are made on the basis of scholarship, financial need, leadership, and promise of success in textile fields. The sum available for scholarship purposes is $500 per year, offered annually at the discretion of the Scholarship Committee.

16. H. Webster Thomas Memorial Scholarship—donated by the Rohm and Haas Corporation of Philadelphia, Pennsylvania

This scholarship is awarded for a four-year period to a student in Leather Engineering at Lowell Technological Institute. The amount of the scholarship is $500 per year.

17. United Elastic Corporation Scholarships

Scholarships in the amount of $250 are available through the United Elastic Corporation, Easthampton, Massachusetts.

These scholarships have been established primarily for employees of the United Elastic Corporation, or members of their families. Other residents of the communities where plants are located, however, may enter applications for consideration. Preference is given to native New Englanders and to those who agree to work summers in approved mills.

Qualifications for scholarships include: good character and standing in the community, aptitude for technical training, and ability to pass entrance requirements of Lowell Technological Institute. With the approval of the United Elastic Corporation and the Lowell Technological Institute, scholarships may be awarded to deserving upperclassmen.

Granting of a scholarship is for a one-year period and further extension if the performance of the student during the year is satisfactory. The United Elastic Corporation will, so far as possible, furnish suitable employment to the student during the summer vacation period and following graduation.

All applications should be made through the plant nearest to the residence of the applicant. Plants are located at Easthampton, Lowell, and Littleton, Massachusetts; West Haven, Connecticut; and Stuart, Virginia.

18. Jacob Ziskind Memorial Scholarship

This scholarship was established by the employees of the Merrimack Manufacturing Company in memory of Jacob Ziskind.

Qualifications for the scholarship include: good character, scholastic record, initiative and ability to pass the entrance requirements at Lowell Technological Institute. Preference in granting the scholarship is given to employees of the Merrimack Manufacturing Company or members of their immediate families residing in the Greater-Lowell area. However, other residents of Greater-Lowell may enter applications for consideration.

The Merrimack Manufacturing Company will, insofar as possible, provide suitable on-the-job training during the summer vacation period and following graduation. The scholarship provides tuition, books, supplies and such deposits as are required to enroll the student in the course selected. The scholarship is renewable providing a satisfactory scholastic record is maintained.

Available for Upperclassmen Only

1. Arthur Besse Memorial Scholarship

The scholarship is awarded by the Arthur Besse Memorial Trust to a student majoring in Woolen and Worsted Manufacturing and planning to continue in that industry after graduation. Awards are based on need, scholarship, and qualities of character and leadership. The amount of the scholarship is $500 a year, and is renewable if a satisfactory scholastic record is maintained.

2. Boston Paper Trade Association Scholarship

This scholarship is open to any sophomore, junior, or senior enrolled in the Paper Engineering Department who is a resident of New England. It is awarded on the basis of scholarship and general character. The amount of the scholarship is $500. It is anticipated that the scholarship will be made renewable each year by the Association.

3. Fiberglas Scholarships—Owens-Corning Fiberglas Corporation

This scholarship is awarded annually to an outstanding sophomore in any of the textile courses. It pays the recipient full tuition and $500 per academic year for each of the junior and senior years. Selection is based upon academic record, character, qualities of leadership, and need.

4. The Gehring Foundation Memorial Scholarship — in memory of Henry G. Gehring and his son, Edward H. Gehring, both of whom were engaged in the Lace Industry.

These scholarships are made possible as a result of the Gehring Memorial Foundation of New York. Selection of recipients made by the Scholarship Committee may be reviewed by the Gehring Foundation. The amount of the scholarship is $75 per semester and is renewable if a satisfactory scholastic record is maintained.

5. Ralph E. Hale Scholarship

This scholarship was established by the Northern New England Section of the American Association of Textile Chemists and Colorists in memory of Ralph E. Hale, 1951 Chairman-elect of the Section. This scholarship is awarded annually to a student at the completion of the junior year in the course in Textile Chemistry. The amount of the scholarship is $250 per year.

6. Interchemical Corporation Scholarship

A one-year scholarship worth $500 has been made available by the Interchemical Corporation of Pawtucket, Rhode Island. The scholarship was established for award to a member of the junior class majoring in chemistry and is awarded on the basis of scholastic achievement, character, and leadership potential.

7. New England Paper Merchants Association Scholarship

This scholarship is open to any sophomore, junior or senior in the Paper Engineering Department who is a resident of New England. It is awarded on the basis of scholarship and general character. The amount of the scholarship is $150. It is anticipated that the scholarship will be made renewable each year by the Association.

8. Paper Engineering Department Scholarships

Three prizes of $100 each are awarded at the beginning of each fall semester to the top ranking students enrolled in each of the sophomore, junior, and senior classes of Paper Engineering.

Three prizes of $100 each are awarded at the beginning of each spring semester on the same basis. These prizes were made available by a number of interested companies for students enrolled in the Paper Engineering Department.

LOAN FUND

A loan fund is available for the purpose of assisting upperclassmen to continue their education at Lowell Technological Institute. Students may make application for a loan through the Faculty Treasurer of the Lowell Textile Associates, Incorporated.

Repayments on any loan which are made while the student is still in school are interest free. Loans repaid after the student leaves school (for whatever reason) bear 4% interest beginning three months after the date at which the student officially leaves school. Repayments are not required until the student separates from Lowell Technological Institute, at which time repayments are due quarterly at a rate of $10.00 per quarter the first year and $70.00 per quarter each year thereafter until the loan is repaid. Additional payments may be made at any time so as to reduce indebtedness at a more rapid rate.

FELLOWSHIPS

There are a number of fellowships which are available to students pursuing graduate studies. These fellowships include:

1. Celanese Corporation of America Fellowship

This fellowship is available for persons accepted for graduate study at the Institute in the fields of textile chemistry and textile engineering. To qualify, the applicant must have a Bachelor of Science degree outside the field of textiles and must be a U. S. citizen. The fellowship pays $1500 per year plus tuition and fees. Application should be made to the Director of the Graduate School at Lowell Technological Institute.

2. Clark Thread Company Fellowship

This fellowship is available only to graduates of textile colleges. The fellowship is made available for graduate work at the Massachusetts Institute of Technology and pays $1200 per year plus tuition. Application should be made directly to M.I.T.

3. Lowell Textile School Fellowship

This fellowship is sponsored by the proprietors of the Locks and Canals on the Merrimack River. It is only open to textile graduates of Lowell Technological Institute and it pays the tuition for graduate work at the Massachusetts Institute of Technology. Application should be made directly to M.I.T.

4. New England Textile Foundation Fellowship

This fellowship is open only to graduates of textile colleges. It is made available for graduate work at the Massachusetts Institute of Technology and pays $1000 per year plus tuition. Application should be made directly to M.I.T.

AFROTC Color Guard

AFROTC Drill Team

First AFROTC Cadet Receives Commission

THE AIR FORCE ROTC UNIT

An Air Force Reserve Officers Training Corps unit was established at the Lowell Technological Institute on July 1, 1951. Instruction began with the opening of the first semester of the academic year 1951–52.

By vote of the Board of Trustees, all able-bodied male students enrolling in Lowell Technological Institute for the first time on or after September 13, 1951 must satisfactorily complete the basic ROTC work (freshman and sophomore years) before receiving a Bachelor of Science degree. The President of the Institute may waive this requirement and permit the substitution of an equivalent amount of work only for those individuals who are not liable to military service under existing laws and regulations (for example, not a citizen of the United States, previous military service, etc.).

Uniforms and all equipment and textbooks required for the ROTC work will be supplied by the United States Air Force. Students in the Advanced Course will receive the standard cash payment allowed by the Air Force in lieu of subsistence.

Mission

The mission of the AFROTC unit is to develop in each cadet those attributes essential to his progressive advancement to a commission as a Second Lieutenant in the United States Air Force Reserve and further, to prepare him to fill positions of increasing responsibility as a commissioned officer in such duties in the Air Force as may be required by the national defense effort.

The AFROTC program takes into consideration the fact that many of the academic subjects in which Institute students are enrolled have as much direct relationship to military duties as they have to a civilian career. The courses contained in the AFROTC curriculum have been carefully selected to augment those academic subjects. The purpose of this course of instruction, then, is to enhance the otherwise high qualifications of the student with a thorough Air Force background.

Basic Course

The work covered in the first two years is considered the Basic Course. In addition to exercises in leadership and drill, this work includes classroom instruction in Introduction to Aviation, Global Geography, International Organizations, Instruments of National Security and the Elements of Aerial Warfare. As stated above, the satisfactory completion of the Basic Course is a requirement for the Bachelor of Science degree in all courses offered at the Institute. Cadets who satisfactorily complete the Basic Course may apply for the

Advanced Course subject to approval by the Selection Board. This normally leads, upon graduation, to a commission as a Second Lieutenant in the Air Force Reserve.

Advanced Course

The Advanced Course, consisting of the last two years of Air Force ROTC instruction supplemented by a summer camp, is designed to develop in the student to the highest degree possible those understandings, attitudes, skills and attributes of leadership considered essential in the development of all Air Force commissioned officers.

Air Science III, taught during the student's junior year, analyzes such problems as command and staff concepts; leadership laboratory; problem-solving techniques; communications process; principles and techniques of learning and teaching; Air Force correspondence and publications; military law and courts, and boards; applied air science, including principles of flight, aircraft engines, aerial navigation, and weather; and functions of the Air Force Base.

Air Science IV, taught during the student's senior year, contains a review of the previous years of air science; a critique of the Summer Camp training; leadership and management; military aspects of world political geography; foundations of national power; military aviation and the art of war; career guidance; and briefing for commissioned service.

Summer Camp

In addition to completing satisfactorily the subjects required in the above generalized curriculum, each cadet enrolled in the Advanced Course is required to supplement his training by attending a summer camp of approximately four weeks duration. Usually this camp is attended during the summer preceding his senior year. Transportation from the legal residence of the cadet to the camp and return, uniforms, food, lodging, and medical and dental care are provided by the Air Force and, in addition, the cadet receives the pay of a basic Airman.

Field Trips

Periodically, the Department of Air Science and Tactics conducts field trips to various Air Force installations for the purpose of orientation. They frequently include range firing and conducted tours of the base. Sometimes a familiarization flight is added. Efforts are made also to assist those cadets who are interested in flying to gain as much information as possible about the operational phase of the Air Force.

Contributions to Student Life

In addition to the military and academic phases of its program, the Department of Air Science and Tactics sponsors various extracurricular activities which are designed to produce a well-rounded cadet. Much of this activity is undertaken by the Arnold Air Society.

Cadet Decorations and Awards

A number of medals are awarded to selected cadets and cadet officers at a special Parade and Review held each spring.

Air Force Association Medal—Normally awarded to the outstanding cadet of the senior class on the basis of his military record for the entire four years of the ROTC program.

Alumni Association Medal—Awarded to the most outstanding cadet, regardless of class, for exemplary achievements in academic, military, and extra curricular activities. This medal is given by the Lowell Technological Institute Alumni Association.

Distinguished Commander Medal—Awarded to a cadet holding the rank of Major or higher for outstanding performance.

Distinguished Squadron Commander Medal—Awarded to a cadet holding the rank of Captain or higher for outstanding performance in leadership and drill.

Distinguished Flight Leader Medals—Awarded to two cadet lieutenants for outstanding performance in leadership and drill.

Distinguished Non-Commissioned Officer Medals—Awarded to the three cadet non-commissioned officers who have distinguished themselves by their excellence in leadership and drill.

Distinguished Cadet Medals—Awarded to the three cadets of the second-year Basic Course who have distinguished themselves through their work in leadership and drill.

In addition to the above medals all cadets are eligible to compete for the following:

Arnold Air Society Scholarship—A scholarship of $100 is awarded periodically to a selected member of one of the Arnold Air Society Squadrons in the First District. The basis for selection is the financial need of the cadet coupled with his academic and military record.

Distinguished Military Graduate—Each year certain AFROTC graduates are selected to receive this honor. The bases of selection are:

(a) Qualities of Military Leadership.

(b) High Moral Character.

(c) Aptitude for Military Service.

(d) Excellence in academic standing and/or outstanding leadership in campus activities.

A Distinguished Military Graduate may be offered a commission as a second lieutenant in the United States Air Force.

PLACEMENT

Industrial Training Program

The Placement Bureau with the assistance of Industry endeavors to place every qualified underclassman during the summer vacation periods in an industrial position similar to the student's major field of interest at the Institute. These training opportunities are available in Chemistry, Electronics, Leather, Paper, and Textiles, and are open to all students except those on scholastic or disciplinary probation.

The objectives of the undergraduate Industrial Training Program are:

(1) To help supply essential industrial experience to the undergraduate.

(2) To provide experience in Human Engineering only obtained in Industry.

(3) To furnish an employment pool enabling industry to preview individual students.

(4) To further the liaison between the Institute and Industry.

Placement Service

The Placement Bureau maintains active contacts with a number of industrial firms throughout the country in each of the fields of engineering presented at the Institute. A complete file of opportunities and data on various industries and companies is available to the members of the graduating class in the Placement Office.

The Placement Bureau arranges for the visits of representatives from industrial firms to interview students. A series of Industry Seminars is conducted in which Industrial speakers outline opportunities in particular industries and the various positions within the companies.

In addition to assisting in the placement of graduating students, it also assists industry in the difficult job of locating trained and experienced personnel. The office also assists Alumni to establish new connections.

The Placement Office, of course, cannot give any graduate a guarantee of employment; however, during the past year the Placement Bureau listed several jobs for every graduate and practically all seniors were placed before Commencement.

COOPERATIVE PLAN

Massachusetts Institute of Technology—Lowell Technological Institute

A cooperative plan of operation between the two institutes has been arranged. The major provisions include:

(1) The mutual use of the manufacturing and research facilities at Lowell Technological Institute and the Textile Division at Massachusetts Institute of Technology for graduate and undergraduate theses.

(2) The mutual use of textile libraries of both institutions.

(3) The opportunity for students at each institute to supplement their work by taking work presented at the other institute.

(4) The formation of joint seminars and the exchange of staff members for special lectures.

(5) Frequent student visits and joint meetings of student societies.

SUMMER SESSION

The Summer Session is designed primarily to serve three principal areas of interest: Professional Advancement Courses for industrial personnel and home economists; Undergraduate Credit Courses for college students with course deficiencies; and Pre-College Refresher Courses for incoming freshmen at L.T.I.

The professional advancement program, comprising a number of specialized, intensive, one to three-week courses, includes the following: Textile Workshop; Fabrics; Textile Testing; several courses in the social sciences; and industry-sponsored training in wool, paper and leather technology. The six-week undergraduate credit program stresses fundamental courses in college mathematics, physics, chemistry, and English. The four-week, pre-college refresher program is especially designed to articulate the high school training of prospective L.T.I. students with the more intensive college level studies in basic mathematics, physics, chemistry, and English.

For further information on the Summer Session, write to Professor Ernest P. James, Director of the Summer School.

EVENING DIVISION

The Evening Division offers a wide variety of courses in engineering, chemistry, textiles, paper, leather, electronics, plastics and the social sciences. These courses are designed to fit the needs of the local community, particularly those people engaged in industry who wish to further their education.

Some of these courses carry graduate school credit and others undergraduate college credit. A substantial number of non-credit courses are also offered to the general public.

The Evening Division does not grant degrees but credits may be transferred to the regular day school towards either the B.S. or M.S. degree. Diplomas in cotton manufacturing, woolen manufacturing, worsted manufacturing, and textile chemistry and dyeing are awarded in the Evening Division for completion of the prescribed program.

Two semesters of 15 weeks each are offered, starting in early October and early February. For further information on the Evening Division, write to Professor Walter M. Drohan, Registrar.

THE GRADUATE SCHOOL

By act of the General Court of 1935, authority was given to Lowell Technological Institute to confer degrees of Master of Science in Textile Chemistry, Master of Science in Textile Engineering, and Master of Science in Textile Manufacturing to graduate students who satisfactorily complete a program of advanced standing. Recently, authority has been granted to include Master of Science work in the fields of Paper Engineering, Electronic Engineering, and Leather Engineering which will lead to corresponding degrees.

The graduate programs of study offered by the Institute provide for advanced specialized training required by technologists who contribute to industrial progress and human welfare through the application of scientific and engineering principles to existing industrial and human problems. The courses of study allow the graduate of the Institute or of other colleges training men in textile, paper, or leather technology to broaden his knowledge and skills in these areas and to develop a sound research approach to problems of the basic sciences, the development of new products, and industrial production.

Inquiries concerning graduate studies should be addressed to the Director of the Graduate School.

I. Admission to the Graduate School

A. *General Admission*

To be eligible for admission to the Graduate School, an applicant must have received a Bachelor's degree in an acceptable four-year course in which he has maintained a uniformly high scholastic rating. Both quality and quantity of the previous training will be considered. Selection of those applicants admitted will be based as far as possible on their ability to pursue graduate work of high quality.

B. *Special Student Status*

An applicant who meets the general admission requirements, but who wishes to concentrate on certain subjects in specialized techniques, or in some cases with special research programs, may request to be considered for Special Student Status. This work would not lead to a degree.

Acceptance as a special student is contingent upon the consent of the instructor in charge of each subject to which admittance is desired.

C. *As a Provisional Graduate Student*

An applicant for admission to the Graduate School who is unable to meet all the requirements specified in (A) may be accepted provisionally, provided he satisfies the department in which he wishes to enroll that he is probably able to pursue graduate studies successfully.

The status of such a student will be changed to that of a graduate student upon demonstration of his ability to pursue graduate studies successfully as measured by the completion of his first academic year's work with an average rating of 2.5 (80%).

D. *Application Procedure*

Those wishing to carry on graduate studies at this Institute should file application with the Director of the Graduate School. Applications may be obtained from the Office of the Graduate School.

Applications for admission should be complete and accurate and must be received not later than the first of June preceding the fall term in which the applicant wishes to enroll. Applications must be supported by letters from at least two persons qualified to judge the ability of the applicant to carry on graduate work and research. The letters should be sent directly from these persons to the Graduate School.

Transcripts of all undergraduate records (and graduate, if any) must be sent directly to the Office of the Graduate School by the institutions which the applicant has previously attended. All transcripts must be official, with appropriate seals and signatures. Records, descriptions of subjects, and letters must be in English. Each subject must be described in terms of content, scope, number of hours per week, and number of weeks duration. Lecture and laboratory time should be properly distinguished. If a catalogue giving such descriptions in English is available, the subjects taken may be clearly marked in a copy sent to the Graduate School.

A reading and speaking knowledge of English is necessary for an applicant to be considered for acceptance. Most of the subjects are presented in lecture form, making it difficult for those who do not have a reasonably fluent command of the English language.

Except in unusual circumstances, applications will be acted upon and the applicant notified of the decision by July 1. Foreign applicants are urged to make application as early as possible so as to leave enough time for visa and other arrangements to be made.

II. Graduate Courses Offered

Graduate programs are offered in the fields of Textile Chemistry, Textile Engineering and Paper Engineering. Starting with the academic year 1955–1956 Electronic Engineering will be added to the graduate program.

Because of the varied objectives of the graduate student, the course of study is arrived at through consultation with the student's graduate advisor.

Subjects numbered 500 and above are offered for graduate credit. A limited number of undergraduate subjects are available for graduate credit. The choice of these undergraduate subjects with graduate credit is subject to the approval of the Department Head.

Each program will include an original thesis.

TEXTILE CHEMISTRY

Graduate work in Textile Chemistry allows qualified students the opportunity to pursue advanced study in the physical chemistry of textile processing such as dyeing, wet finishing and fiber modification. Studies on the organic chemistry of dyes may also be undertaken.

Recent studies have been on the theories of dyeing of natural and synthetic fibers and the application of synthetic finishes.

Such studies are carried out by graduate class work, seminars, and original theses.

The following subjects must be included in the student's program:

First Semester:

CH 503	Interpretation of Data
CH 505	Physical Chemistry of Dyeing
CH 531	Textile Chemistry Seminar

Second Semester:

CH 512	Physical Chemistry of Surface-Active Agents
CH 516	Chemical Thermodynamics
CH 532	Textile Chemistry Seminar

Other subjects of his own selection are to be added to give a suitable program.

TEXTILE ENGINEERING

Graduate work in Textile Engineering is offered so that qualified students who have completed one of the courses in Textile Engineering at Lowell Technological Institute may undertake advanced studies concerning the physical properties of textile materials and modern methods of evaluating them.

Opportunity is also provided for engineering graduates of other colleges to secure fundamental knowledge of textile materials and processing which is a co-requisite for graduate study and research in Textile Engineering.

For graduate subjects in Textile Engineering consult subject descriptions under Engineering, Mathematics, and Physics.

PAPER ENGINEERING

The graduate program in Paper Engineering is for the purpose of giving advanced work in papermaking, paper converting or allied fields.

The Paper Engineering Department will consider graduate students from three different sources:

(a) Graduates of the Lowell Technological Institute B.S. Paper Engineering course.

(b) Paper Engineering B.S. and M.S. graduates of other schools.

(c) General B.S. and M.S. Engineering graduates with no previous paper training.

Students with the backgrounds given under (a) and (b) should be able to complete the work in one academic year. Students in group (c) should be able to complete the degree requirements in two academic years.

A graduate student in Paper Engineering will take approximately 50% of his graduate subjects (including thesis) in the Paper Engineering Department. The balance may be taken as electives related to the paper field and approved by the Department.

The graduate subjects offered in this Department are:

PA 501–502 Graduate Thesis
PA 503–504 Advanced Paper Microscopy
PA 505–506 Advanced Papermaking and Paper Converting

ELECTRONIC ENGINEERING

A program leading to the degree of Master of Science in Electronic Engineering will be offered starting with the academic year 1955–1956. Students desiring to do graduate work in this area should present credits in electronics, physics and mathematics substantially equivalent to those required of undergraduate students in Electronic Engineering at this Institute. Students unable to satisfy these requirements may be admitted to the graduate school on a provisional basis. Such students will then be required to make up undergraduate deficiencies, by course work or examination, to attain full graduate status.

As part of the course work the student will be required to take two semesters of graduate work in each of the following: electricity, physics, mathematics, and the electronics seminars. The remainder of the graduate work is to consist of approved subjects, special problems in electronics, or original research resulting in a thesis.

III. Term of Residence

Applicants with a sufficient background in their chosen field of concentration will normally require one academic year of residence to complete the requirements for the Master's degree. Those with no background will require a minimum of two years of residence.

IV. Expenses

Tuition, fees, and other expenses for graduate students are for the most part the same as given on page 29 "Student Expenses" for undergraduate students.

Thesis-Binding Fee

All graduate students are required to pay for the expense of binding the original thesis which will be retained in the Institute Library. Certain departments will also require a bound copy of the thesis to be deposited in the department's library.

Both of these expenses must be paid at the Library prior to registering for the thesis work. The receipt obtained from the Library will allow the student to register for the subject.

V. Candidacy for a Degree

Admission to the Graduate School does not indicate that the student is a candidate for the Master's degree. A student enrolled in a graduate degree program, who has established an acceptable scholarship record and has completed half of the required program, may make application to the Director of the Graduate School to become a candidate for the degree.

Application for approval of candidacy for the advanced degree must be filed after completion of one-half of the required program and not later than twelve weeks prior to the date on which the degree is to be conferred.

VI. Requirements for Graduation

To be recommended for the Master of Science degree a candidate must have fulfilled the following requirements:

(a) Completed a course of study approved by the department in which he has been enrolled. The approved course of study is to have a minimum of 30 credit hours, including thesis. A minimum of 20 credit hours is to be spent in listed subjects, and the program should have no fewer than 5 credit hours of thesis work.

(b) Completed a thesis (original research or other investigation, optional with department) approved by the department in which he has been enrolled. Successfully passed any oral or written examinations on his thesis required by the department at the time his thesis is submitted for final approval.

(c) Maintained residence for at least one academic year.

(d) Maintained an average rating of B in graduate subjects and passed all undergraduate subjects submitted for graduate credit with a grade of B or better.

UNDERGRADUATE PROGRAMS OF STUDY

Curricula

The undergraduate program is organized into nine curricula options each of which covers a major field. All are of four years' duration and lead to the degree of Bachelor of Science.

Electronic Engineering
Leather Engineering
Paper Engineering
Plastic Engineering
Textile Chemistry
Textile Engineering—Engineering Option
Textile Engineering—General Manufacturing Option
Textile Manufacturing
Textile Sales and Management

Each of the nine curricula is presented in outline form following the "Freshman Year" explanation.

The curricula of the Institute are under constant study. Revisions are made whenever it is clearly indicated that changes are necessary in order for the Institute to fulfill its traditional purpose of service to the industries. In choosing the present curricula, the Administration and Faculty have been aware of their obligation to prepare students for entrance into the industry of their choice whether it be the Electronics, Chemistry, Leather, Paper, Plastics, Textiles, or similar fields. In addition to fundamental courses in the physical sciences and engineering, considerable work in practical industrial applications has been included. Broadening yet practical courses in English and the social sciences have been woven into all curricula in a conscious effort to produce graduates who are not only well trained technically but are prepared to take their places in society.

Curricula Revision

A new Textile Manufacturing Curriculum has been established to be presented for the first time to the entering freshmen (Class of 1958). It is designed to replace the former Course I, Cotton Manufacture; Course II, Wool Manufacture; Course III, Textile Design; and Course V, Synthetic Textiles.

Courses I, II, III and V will be offered to the Sophomore (Class of 1957), Junior (Class of 1956) and Senior (Class of 1955) Classes. The curricula of these courses will be found in the Appendix.

These revisions have necessitated a number of changes in the other curricula. Therefore, Course IV, Textile Chemistry; Course VI-G, Textile Engineering—General Manufacturing Option; and Course VII, Textile Sales and Management, have new programs which will be established beginning with the entering freshmen (Class of 1958). The curricula for the Sophomore (Class of 1957), Junior (Class of 1956), and Senior (Class of 1955) Classes for these courses will be found in the Appendix.

The curricula for Textile Engineering—Engineering Option (former Course VI-E), Leather Engineering (former Course IX), Paper Engineering (former Course VIII), Electronic Engineering (former Course X), and Plastic Engineering will apply to the entering Freshmen (Class of 1958) as well as the Sophomore, Junior and Senior Classes enrolled in those courses. The curricula for these courses will be found on the following pages.

THE FRESHMAN PROGRAM

The first semester of the freshman year is common to all curricula except Electronic Engineering. With the start of the second semester of the first year, the student is permitted to undertake a limited amount of work in his field of specialization. However, continued emphasis is given to the fundamental studies in Mathematics, Physics, Chemistry and Humanities.

The program for all freshmen, except those enrolled in Electronic Engineering, during the first semester is as follows:

FRESHMAN YEAR

First Semester

			Credit Hours
CH 101	General Inorganic Chemistry	(5-3)	6
EN 111	Engineering Drawing	(0-6)	2
GS 111	English Composition	(2-2)	3
*MA 101	College Mathematics	(3-2)	4
	Physical Education	(0-1)	0
AS 101	Air Science	(2-1)	2
	—or—		
GS 101	World Economic Geography	(2-0)	2
	Total		17

Freshman Orientation

The first week's program in the fall for entering freshmen is called Freshman Week. It is devoted to facilitating the adjustment of the new student to his physical and social surroundings. Under the sponsorship of the Office of Dean of Students, a program of meetings, lectures and conferences will be presented in order to acquaint the entering class with the traditions, customs, rules and regulations, courses of instruction, organizations, recreational activities and other facilities of Lowell Technological Institute.

During Freshman Week, each student will be assigned a member of the faculty who will serve as his faculty adviser during the freshman year. These advisers assist the student in solving his academic and personal problems.

All new students at the Institute are required to attend the program of Freshman Orientation. This program carries no credits but it is designed to assist the freshman in making his adjustment to college life. It guides him in making the most efficient use of his time and talents, attempts to develop his ability to think for himself and react thoughtfully and intelligently to new ideas and viewpoints.

During this week also, each freshman is required to take certain achievement and aptitude tests which are used to guide him in course selection and to ascertain his chances of success on the collegiate level.

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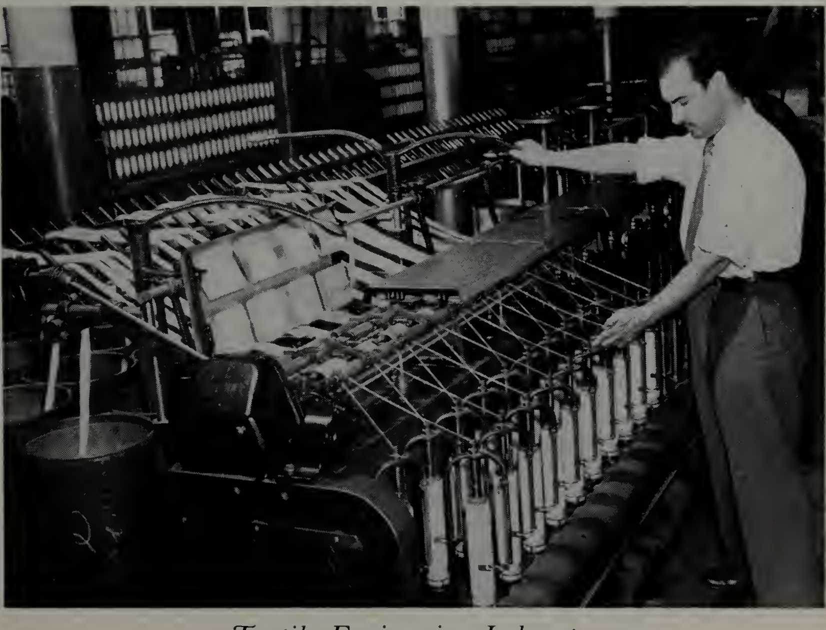
*Students with special mathematical aptitude and training may be given an opportunity to start their college mathematics at an advanced level and thereby complete the mathematical requirements of their course one semester earlier.

Paper Engineering Students



Textile Engineering Laboratory

Student in Leather Engineering Laboratory

Research With Radioactive Materials

ELECTRONIC ENGINEERING

The objective of the curriculum in Electronic Engineering is to provide the student with a sound foundation for a professional career in electronics. Toward this end he is given a thorough grounding in electronic science and engineering together with an intensive training in mathematics and physics.

In all courses in electronics and physics the techniques of experimental science and technology are emphasized by investigative work in the laboratory and lecture demonstrations in the classroom.

Studies in the humanities and social sciences form an important part of the program since these subjects broaden the student's outlook. They also serve to focus attention on the importance of non-technical knowledge in determining the student's ultimate level of responsibility in professional life. Emphasis is placed on the development of the student's ability to speak and write effectively so that he can express his thoughts and the results of his experimental investigations with clarity.

The following curriculum is applicable to all four undergraduate classes.

FRESHMAN YEAR

First Semester

*AS 101	Air Science and Tactics	(2-1)2
CH 101	General Inorganic Chemistry	(5-3)6
EN 113	Engineering Drawing	(0-3)1
GS 111	English Composition	(2-2)3
MA 101	College Mathematics	(3-2)4
PH 103	Elementary Engineering Physics	(4-0)4
	Total credit hours	20
*Alternate:		
GS 101	World Economic Geography	(2-0)2

Second Semester

*AS 102	Air Science and Tactics	(2-1)2
CH 104	General Inorganic Chemistry	(2-0)2
EN 122	Machine Tool Laboratory	(1-2)1
GS 112	English Composition and Readings	(2-2)3
MA 106	Elementary Engineering Mathematics	(5-0)5
PH 104	Elementary Engineering Physics	(5-0)5
	Total credit hours	18
*Alternate:		
GS 102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS 201	Air Science and Tactics	(2-1)2
CH 331	Physical Chemistry	(3-1½)4
EL 201	Introductory Circuit Theory	(3-0)3
EL 203	Elementary Electricity and Magnetism Laboratory	(0-3)1
MA 207	Intermediate Engineering Mathematics	(4-0)4
PH 205	Intermediate Engineering Physics	(3-0)3
*Elective		(3-0)3
	Total credit hours	20
*Alternate and Elective:		
GS 201	Economics	(3-0)3
	or	
	Other General Studies subject approved by the Department Head	(3-0)3

Second Semester

*AS 202	Air Science and Tactics	(2-1)2
CH 332	Physical Chemistry	(3-3)4
EL 202	Introductory Circuit Theory	(3-0)3
EL 204	Elementary Electricity and Magnetism Laboratory	(0-3)1
MA 208	Differential Equations for Engineers	(3-0)3
PH 206	Intermediate Engineering Physics	(3-0)3
*Elective		(3-0)3
	Total credit hours	19
*Alternate and Elective:		
GS 226	World History Since 1900	(3-0)3
	or	
	Other General Studies subject approved by the Department Head	(3-0)3

JUNIOR YEAR

First Semester

EL 301	Introduction to Physical Electronics	(3-0)3
EL 303	Electronic Circuits	(3-0)3
EL 305	Electronics Laboratory	(0-4)2
EL 307	Electromagnetic Devices and Machinery	(3-0)3
EL 309	Instrumentation and Electromagnetics Laboratory	(0-4)2
MA 301	Advanced Calculus for Engineers	(3-0)3
*Elective		3 or 4
	Total credit hours	19 or 20

*Electives:

AS 301	Air Science and Tactics	(4-1)4
GS 303	Psychology	(3-0)3
	Other General Studies subject approved by the Department Head	(3-0)3

Second Semester

EL 302	Introduction to Physical Electronics	(3-0)3
EL 304	Electronic Circuits	(3-0)3
EL 306	Electronics Laboratory	(0-4)2
EL 308	Electromagnetic Devices and Machinery	(3-0)3
EL 310	Instrumentation and Electromagnetics Laboratory	(0-4)2
MA 302	Advanced Calculus for Engineers	(3-0)3
*Elective		3 or 4
	Total credit hours	19 or 20

*Electives:

AS 302	Air Science and Tactics	(4-1)4
GS 224	The United States Since 1865	(3-0)3
	Other General Studies subject approved by the Department Head	(3-0)3

SENIOR YEAR

First Semester

EL 401	Industrial Electronics and Servomechanisms	(3-0)3
EL 403	Communication and Microwave Electronics	(3-0)3
EL 405	Introduction to Solid State Electronics	(3-0)3
EL 407	Experimental Electronic Techniques	(1-0)1
EL 409	Electronic Projects Laboratory	(0-4)2
EL 411	Applied Electronics Laboratory	(0-4)2
PH 411	Advanced Engineering Physics	(3-0)3
*Elective		3 or 4
	Total credit hours	20 or 21

*Electives:

AS 401	Air Science and Tactics	(4-1)4
GS 461	Personnel Management	(3-0)3
	Other General Studies subject approved by the Department Head	(3-0)3

Second Semester

EL	402	Industrial Electronics and Servomechanisms	(3-0)3
EL	404	Communication and Microwave Electronics	(3-0)3
EL	406	Introduction to Solid State Electronics	(3-0)3
EL	408	Experimental Electronic Techniques	(1-0)1
EL	410	Electronic Projects Laboratory	(0-4)2
EL	412	Applied Electronics Laboratory	(0-4)2
PH	414	Advanced Engineering Physics	(3-0)3
*Elective			2 to 4
		Total credit hours	19 to 21

*Electives:

AS	402	Air Science and Tactics	(4-1)4
GS	468	Business Finance	(2-0)2
		Other General Studies subject approved by the Department Head	(3-0)3

Leather Engineering

The concept of a leather engineer is new to the leather industry. The economic size of this industry as well as the scope and number of its problems warrants the careful training of individuals capable of handling the specific problems which arise in this industry.

The leather industry realizes that many of its products can be improved by the application of sound and intelligent research and development. The demand is growing for engineers having a basic understanding of the art of leather manufacturing.

In this curriculum, emphasis is placed on the fundamentals of engineering including mathematics, physics, chemistry, and theoretical and applied mechanics. These subjects are basic in any sound undergraduate program. Since the undergraduate student cannot be left with a great collection of tools which he does not understand, subjects are offered in the application of their basic scientific principles to leather technology.

In order to properly balance this program, subjects in general education are offered, since the engineer, as well as being trained to be a leader in his profession, must also be trained to be a leader in everyday economic, social and political affairs. He must also be trained to meet success, promotion, and the challenge of directing the work of others.

The following curriculum is applicable to all four undergraduate classes. A special program of new subjects will be presented to the Sophomore (Class of 1957) Class as noted below.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	104	General Inorganic Chemistry	(2-0)2
CH	124	Elementary Stoichiometry	(2-0)1
EN	112	Engineering Drawing	(0-6)2
GS	112	English Composition and Readings	(2-2)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	19
*Alternate:			
GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR (except for Class of 1957)

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	121	Qualitative Analysis	(1-6)3
CH	201	Organic Chemistry	(3-3)4
EN	223	Applied Mechanics	(3-0)3
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
		Total credit hours	19
*Alternate:			
GS	201	Economics	(3-0)3

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	214	Quantitative Analysis	(2-6)4
LE	202	Applied Leather Analysis	(1-4)2
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	19
Alternate:			
GS	202	Economics	(3-0)3

JUNIOR YEAR

First Semester

CH	331	Physical Chemistry	(3-1½)4
LE	301	Leather Manufacture	(3-6)5
LE	303	Leather Histology	(3-3)4
*Electives			6 or 7
		Total credit hours	19 or 20
*Electives:			
AS	301	Air Science and Tactics	(4-1)4
		Electives chosen in one of the following fields: Sales, Management, Humanities, Finance, or Research	

Second Semester

CH 332	Physical Chemistry	(3-3)4
LE 302	Leather Manufacture	(3-6)5
LE 304	Advanced Leather Histology	(3-3)4
*Electives		6 or 7
	Total credit hours	19 or 20

*Electives:

AS 302	Air Science and Tactics	(4-1)4

Electives must be in the field selected in the first semester

SENIOR YEAR

First Semester

EN 351	Statistical Methods	(3-0)3
LE 401	Leather Manufacture	(3-6)5
LE 405	Leather Seminar	(1-0)1
PH 321	Electronics	(3-1)3
*Electives		6 or 7
	Total credit hours	18 or 19

*Electives:

AS 401	Air Science and Tactics	(4-1)4

Electives must be in the area of studies selected in the Junior year

Second Semester

EN 344	Electrical Machinery	(3-2)4
LE 402	Leather Manufacture	(3-6)5
LE 404	Properties of Leather	(2-3)3
LE 406	Leather Seminar	(1-0)1
*Electives		6 or 7
	Total credit hours	19 or 20

*Electives:

AS 402	Air Science and Tactics	(4-1)4

Electives are to be chosen in the special field selected in the Junior year

SOPHOMORE YEAR (Class of 1957 only)

First Semester

*AS 201	Air Science and Tactics	(2-1)2
CH 201	Organic Chemistry	(3-3)4
CH 213	Quantitative Analysis	(2-6)4
GS 211	Business English	(1-0)1
MA 201	Analytic Geometry and Calculus	(4-0)4
PH 201	Physics	(3-2)4
	Total credit hours	19

*Alternate:

GS 201	Economics	(3-0)3

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
CH	202	Organic Chemistry	(3-3)4
EN	222	Applied Mechanics	(3-0)3
LE	202	Applied Leather Analysis	(1-4)2
MA	202	Analytic Geometry and Calculus	(4-0)4
PH	202	Physics	(3-2)4
		Total credit hours	19

*Alternate:

GS	202	Economics	(3-0)3

Paper Engineering

The object of this course is to fit a man for work in the paper-making, paper-converting, or allied industries. For this, a thorough training in basic chemical engineering is offered, accompanied by instruction in the theory and practice of pulp and paper manufacture and paper converting.

Paper engineering involves the application of cellulose and plastics chemistry together with engineering principles to the handling of the material in the web or sheet form, as it is treated, coated, or converted into the final product. Every effort is made by cooperation with local concerns to supplement college work by experience in actual manufacturing conditions, thus giving the student an opportunity to familiarize himself with equipment commonly in use in the industry.

Students taking this course should be well equipped for work in the paper-making or paper-converting fields, or for graduate study in paper technology.

The curriculum outlined below should be regarded as provisional in character.

The following curriculum is applicable to all four undergraduate classes. A special program of new subjects will be presented to the Sophomore (Class of 1957) Class as noted below.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	104	General Inorganic Chemistry	(2-0)2
CH	124	Elementary Stoichiometry	(2-0)1
EN	112	Engineering Drawing	(0-6)2
GS	112	English Composition and Readings	(2-2)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	19
*Alternate:			
GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR (except for Class of 1957)

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	201	Organic Chemistry	(3-3)4
CH	121	Qualitative Analysis	(1-6)3
EN	223	Applied Mechanics	(3-0)3
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
		Total credit hours	19
*Alternate:			
GS	201	Economics	(3-0)3

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	214	Quantitative Analysis	(2-6)4
GS	210	Speech	(2-0)2
GS	212	Business English	(1-0)1
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	20
*Alternate:			
GS	202	Economics	(3-0)3

JUNIOR YEAR

First Semester

CH	331	Physical Chemistry	(3-1½)4
CH	333	Industrial Stoichiometry	(3-0)3
PA	301	Pulp and Paper Manufacture	(3-0)3
PA	303	Pulp Manufacture, Testing and Analysis	(2-6)4
PH	321	Electronics	(3-1)3
*Electives			3 or 4
		Total credit hours	20 or 21
*Electives:			
AS	301	Air Science and Tactics	(4-1)4
		A General Studies subject	(3-0)3

Second Semester

CH 332	Physical Chemistry	(3-3)4
CH 352	Chemical Engineering	(3-0)3
CH 362	General Colloid Chemistry	(2-0)2
PA 302	Pulp and Paper Manufacture	(3-0)3
PA 312	Paper Manufacture, Testing and Analysis	(2-6)4
*Electives		3 or 4
	Total credit hours	19 or 20

*Electives:

AS 302	Air Science and Tactics	(4-1)4
	A General Studies subject	(3-0)3

SENIOR YEAR

First Semester

CH 441	Advanced Chemical Engineering	(3-0)3
EN 351	Statistical Methods	(3-0)3
PA 405	Paper Converting Laboratory	(2-6)4
PA 407	Paper Coating and Converting	(3-0)3
*Electives		6 or 7
	Total credit hours	19 or 20

*Electives:

AS 401	Air Science and Tactics	(4-1)4
	General Studies subjects	

Second Semester

CH 442	Chemical Engineering Thermodynamics	(3-0)3
EN 420	Industrial Instrumentation	(2-3)3
EN 344	Electrical Machinery	(3-2)4
PA 408	Mill Inspection	(1-4)2
PA 414	Advanced Paper Problems	(2-6)4
*Electives		3 or 4
	Total credit hours	19 or 20

*Electives:

AS 402	Air Science and Tactics	(4-1)4
	A General Studies subject	(3-0)3

SOPHOMORE YEAR (Class of 1957 only)

First Semester

*AS 201	Air Science and Tactics	(2-1)2
CH 201	Organic Chemistry	(3-3)4
CH 213	Quantitative Analysis	(2-6)4
GS 211	Business English	(1-0)1
MA 201	Analytic Geometry and Calculus	(4-0)4
PH 201	Physics	(3-2)4
	Total credit hours	19

*Alternate:

GS 201	Economics	(3-0)3

Second Semester

*AS 202	Air Science and Tactics	(2-1)2
CH 202	Organic Chemistry	(3-3)4
EN 222	Applied Mechanics	(3-0)3
GS 210	Speech	(2-0)2
MA 202	Analytic Geometry and Calculus	(4-0)4
PH 202	Physics	(3-2)4
	Total credit hours	19

*Alternate:

GS 202	Economics	(3-0)3

Plastic Engineering

This curriculum has as its objective the training of engineers specifically prepared to cope with the many technical and production problems found in the rapidly expanding field of plastics fabrication.

This course is being offered for the first time in September 1954 and the entering freshman class (Class of 1958) will contain the first students in this new area of specialization.

The emphasis is on the engineering principles involved in the fabrication of plastic materials into useful forms rather than the chemistry involved in the manufacture of the plastic material itself. Due to the close relationship involved between the physical and chemical properties of such materials, however, the curriculum involves considerably more chemistry than most engineering courses.

A basic training in mathematics and physics is required as well as elementary and advanced engineering subjects. In the third and fourth years this basic knowledge is focused on the problems of the plastics industry, including design, manufacture and testing.

Courses in the humanities and applied economics round out the education of the plastics engineer and equip him to advance to the administrative as well as the purely technological type of position.

Curriculum

The curriculum for the plastic engineering course is still undergoing revision by the Advisory Committee, composed of leaders in the plastics industry, and will not be officially announced until September 1954. Those wishing a copy of the curriculum after that date may obtain one by writing to the Director of Admissions, Lowell Technological Institute.

Textile Chemistry

The curriculum is designed to train those who wish to engage in the textile chemistry field which includes the bleaching, scouring, dyeing, printing, and finishing of textiles, or those who are interested in the manufacture, demonstration, and sale of dyestuffs, detergents, and other chemicals used in the textile industry.

This course provides a basic training in chemistry, physics, and mathematics. To this is added theoretical and practical training in bleaching, dyeing, printing and finishing, given in the junior and senior years.

Courses in the humanities are also required in the hope that with a broader training the graduate will become a more valuable member of his community as well as a success in his chosen profession.

Students having difficulty in color perception, while unfitted for employment in dyehouses or with dyestuff concerns, are capable of having a successful career in other branches of Textile Chemistry.

The following curriculum is applicable to the entering Freshman (Class of 1958) Class. The program for the Sophomore (Class of 1957), Junior (Class of 1956), and Senior (Class of 1955) Classes will be found in the Appendix.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	104	General Inorganic Chemistry	(2-0)2
CH	122	Qualitative Analysis	(1-6)3
CH	124	Elementary Stoichiometry	(2-0)1
GS	112	English Composition and Readings	(2-2)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	20
*Alternate:			
GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	201	Organic Chemistry	(3-3)4
CH	211	Quantitative Analysis	(2-6)4
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
TE	101	Elementary Textile Design	(2-1)2
		Total credit hours	19
*Alternate:			
GS	261	Technical German	(3-0)3

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	204	Chemical Technology of Fibers	(2-0)2
CH	212	Quantitative Analysis	(2-6)4
MA	204	Mathematics for Chemists	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	19
*Alternate:			
GS	262	Technical German	(3-03)

JUNIOR YEAR

First Semester

CH	311	Textile Quantitative Analysis	(1-3)2
CH	321	Textile Chemistry	(2-3)3
CH	331	Physical Chemistry	(3-1½)4
GS	201	Economics	(3-0)3
TE	305	Elements of Textile Manufacture	(3-3)4
TE	403	Textile Evaluation	(2-2)3
*Electives			3 or 4
		Total credit hours	22 or 23

*Electives:

AS	301	Air Science and Tactics	(4-1)4
CH	333	Industrial Stoichiometry	(3-0)3
EN	351	Statistical Methods	(3-0)3
GS	361	Advanced Technical German	(3-0)3

Second Semester

CH	322	Textile Chemistry	(2-3)3
CH	332	Physical Chemistry	(3-3)4
CH	364	Textile Colloid Chemistry	(4-0)4
GS	202	Economics	(3-0)3
TE	300	Fabrics	(2-0)2
TE	404	Textile Evaluation	(2-2)3
*Electives			2 to 4
		Total credit hours	21 to 23

*Electives:

AS	302	Air Science and Tactics	(4-1)4
CH	312	Textile Quantitative Analysis	(1-3)2
CH	342	Organic Qualitative Analysis	(1-3)2
CH	352	Chemical Engineering	(3-0)3
GS	362	Advanced Technical German	(3-0)3

SENIOR YEAR

First Semester

CH	411	Advanced Textile Chemistry and Dyeing	(2-9)5
CH	421	Advanced Chemical Textile Testing	(2-3)3
GS	351	Elements of Marketing	(2-0)2
TE	409	Woolen and Worsted Finishing	(3-3)4
*Electives			4 to 6
		Total credit hours	18 to 20

*Electives:

AS	401	Air Science and Tactics	(4-1)4
		Other subjects approved by the Division Head	

Second Semester

CH	412	Advanced Textile Chemistry and Dyeing	(2-9)5
GS	302	Modern Labor Problems	(3-0)3
TE	408	Cotton and Synthetic Finishing	(3-3)4
*Electives			6 to 8
		Total credit hours	18 to 20

*Electives:

AS	402	Air Science and Tactics	(4-1)4
		Other subjects approved by the Division Head	

Textile Engineering

Engineering Option

A textile engineer is defined as one who has had a basic training in engineering to which has been added a thorough grounding in the manufacture of textiles, their properties and uses.

It is the belief that except in highly specialized areas, e.g., chemistry, the ideal training for the textile industry combines an understanding of textile processing relating to all fibers, a sound engineering and scientific background, as well as an orientation to society and business through a selected core of liberal arts and economic subjects.

The Engineering Option provides a training in Mechanical Engineering similar to that found in other engineering schools. To this is added a knowledge of Textiles sufficient to prepare the individual for positions in the textile and allied industries which may involve research and engineering principles. Business subjects and the humanities are included in the curriculum so that this type of textile engineer may have the educational potential to rise to a position of executive responsibility.

Certain subject descriptions not found in the section entitled "Subject Descriptions" will be found in the appendix.

The following curriculum is applicable to all four undergraduate classes.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS 102	Air Science and Tactics	(2-1)2
CH 102	General Inorganic Chemistry	(2-3)3
EN 114	Engineering Drawing	(0-3)1
EN 122	Machine Tool Laboratory	(1-2)1
GS 112	English Composition and Readings	(2-2)3
MA 102	College Mathematics	(3-2)4
PH 102	Physics	(4-2)5
	Total credit hours	19
*Alternate:		
GS 102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS 201	Air Science and Tactics	(2-1)2
DES 103	Yarn Calculation	(1-0)1
EN 201	Machine Drawing	(0-3)1
EN 221	Textile Mechanism	(1-2)2
EN 233	Machine Tool Laboratory	(0-3)1
MA 201	Analytic Geometry and Calculus	(4-0)4
PH 201	Physics	(3-2)4
TE 101	Elementary Textile Design	(2-1)2
WOOL 311	Survey of Wool Manufacture	(3-1)3
	Total credit hours	20
*Alternate:		
GS 209	Speech	(2-0)2
	and	
GS 211	Business English	(1-0)1

Second Semester

*AS 202	Air Science and Tactics	(2-1)2
COT 332	Cotton Yarn Manufacture Survey	(3-1)3
DES 224	Fabric Design and Analysis for Engineers	(2-1)2
DES 234	Fabric Design and Analysis for Engineers	(2-1)2
EN 222	Applied Mechanics	(3-0)3
MA 202	Analytic Geometry and Calculus	(4-0)4
PH 202	Physics	(3-2)4
SYN 322	Filament Yarns Survey	(2-0)1½
	Total credit hours	21½
*Alternate:		
GS 222	Appreciation of Literature	(3-0)3
	or	
GS 226	World History Since 1900	(3-0)3

JUNIOR YEAR

First Semester

EN 301	Advanced Applied Mechanics	(3-0)3
EN 331	Mill Engineering	
	or	
EN 351	Statistical Methods	(3-0)3
GS 201	Economics	(3-0)3
PH 321	Electronics	(3-2)4
TE 403	Textile Evaluation	(2-2)3
WEAV 333	Weaving for Engineers	(1-2)1½
*Electives		3 or 4
	Total credit hours	20½ or 21½

*Electives:

AS 301	Air Science and Tactics	(4-1)4
	Subject approved by Department Head	3

Second Semester

EN 302	Advanced Applied Mechanics	(3-0)3
EN 312	Heat Engineering	(3-2)4
EN 342	Principles of Electrical Engineering	(3-2)4
TE 300	Fabrics	(2-0)2
TE 404	Textile Evaluation	(2-2)3
WEAV 334	Weaving for Engineers	(1-2)1½
*Electives		3 or 4
	Total credit hours	20½ or 21½

*Electives:

AS 302	Air Science and Tactics	(4-1)4
GS 202	Economics	(3-0)3

SENIOR YEAR

First Semester

EN 401	Principles of Electrical Engineering	(3-2)4
EN 411	Advanced Heat Engineering	(2-2)3
EN 425	Engineering Design of Textile Structures	(2-0)2
EN 431	Advanced Physical Testing	
	or	
PH 401	Textile Microscopy	(1-3)2
GS 341	Accounting I	(3-0)3
TE 421	Cotton and Synthetic Finishing	(3-3)4
*Electives		3 or 4
	Total credit hours	21 or 22

*Electives:

AS 401	Air Science and Tactics	(4-1)4
GS 301	Economic Development of the United States	(3-0)3

Second Semester

EN 402	Textile Applications of Electricity	(1-4)1
EN 422	Industrial Instrumentation	(2-0)2
EN 426	Engineering Design of Textile Structures	(2-0)2
FIN 412	Woolen and Worsted Finishing	(3-3)4
GS 412	Industrial Management	(3-0)3
EN 424	Machine Design	(2-2)3
	or	
KNIT 404	Knitting	(2-3)3
	or	
MA 402	Differential Equations	(3-0)3
	or	
PH 402	Textile Physics	(2-3)3
*Electives		3 or 4
	Total credit hours	18 or 19

*Electives:

AS 402	Air Science and Tactics	(4-1)4
GS 302	Modern Labor Problems	(3-0)3

Textile Engineering

General Manufacturing Option

A textile engineer is defined as one who has had a basic training in engineering to which has been added a thorough grounding in the manufacture of textiles, their properties and uses.

It is the belief that except in highly specialized areas, e.g., chemistry, the ideal training for the textile industry combines an understanding of textile processing relating to all fibers, a sound engineering and scientific background, as well as an orientation to society and business through a selected core of liberal arts and economic subjects.

The objective of the General Manufacturing Option is to provide the textile industry with technically trained textile engineers. The curriculum has been planned so that the textile engineer (1) shall be given as complete and thorough a knowledge and understanding of the raw materials, machines, and processes peculiar to the manufacture of all fibers as is possible; (2) shall have a basic training in engineering and the fundamental sciences; and (3) shall acquire a knowledge of business and managerial principles and the social sciences.

The first component should prepare the student to be useful in any textile plant regardless of fiber processed. The second should develop a man who will approach textile problems from an engineering viewpoint thus contributing toward their solution the benefits of a trained analytical mind. The third objective should aid in the production of a well-rounded individual.

The following curriculum is applicable to the entering Freshman (Class of 1958) Class. The program for the Sophomore (Class of 1957), Junior (Class of 1956), and Senior (Class of 1955) Classes will be found in the Appendix.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	102	General Inorganic Chemistry	(2-3)3
EN	114	Engineering Drawing	(0-3)1
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(2-2)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	19

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

AS	201	Air Science and Tactics or Alternate	(2-1)2
EN	201	Machine Drawing	(0-3)1
EN	203	Mechanism	(3-0)3
GS	201	Economics	(3-0)3
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
TE	203	Textile Fibers	(4-0)4
		Total credit hours	20

Second Semester

AS	202	Air Science and Tactics or Alternate	(2-1)2
EN	220	Textile Mechanism	(1-2)2
EN	222	Applied Mechanics	(3-0)3
GS	202	Economics	(3-0)3
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
TE	206	Yarn Manufacture	(3-3)4
		Total credit hours	21

JUNIOR YEAR

First Semester

CH	203	Elementary Organic Chemistry	(3-0)3
EN	301	Advanced Applied Mechanics	(3-0)3
PH	321	Electronics	(3-1)3
TE	307	Yarn Manufacture	(3-3)4
TE	309	Fabric Manufacture	(2-2)2
*Electives			3 or 4
		Total credit hours	18 or 19

*Electives:

AS	301	Air Science and Tactics	(4-1)4
		General Studies subject	(3-0)3

Second Semester

CH 302	Introduction to Textile Chemistry	(1-3)2
EN 344	Electrical Machinery	(3-2)4
EN 352	Statistical Methods	(3-0)3
TE 308	Yarn Manufacture	(3-3)4
TE 310	Fabric Manufacture	(3-3)4
*Electives		3 or 4
	Total credit hours	20 or 21

*Electives:

AS 302	Air Science and Tactics	(4-1)4
	General Studies subject	(3-0)3

SENIOR YEAR

First Semester

EN 403	Principles of Heat Engineering	(3-2)4
GS 341	Accounting I	(3-0)3
TE 403	Textile Evaluation	(2-2)3
TE 405	Textile Finishing	(2-3)3
*Electives		6 or 7
	Total credit hours	19 or 20

*Electives:

	A General Studies subject	(3-0)3
	and one of the following:	
AS 401	Air Science and Tactics	(4-1)4
EN 507	Fluid Mechanics	(3-0)3
TE 407	Knitting	(2-3)3
TE 417	Cotton Mill Organization	(4-0)4

Second Semester

GS 210	Speech	(2-0)2
GS 212	Business English	(1-0)1
GS 412	Industrial Management	(3-0)3
TE 404	Textile Evaluation	(2-2)3
TE 406	Textile Finishing	(2-3)3
*Electives		6 to 10
	Total credit hours	18 to 22

*Electives:

	A General Studies subject	(3-0)3
	and two of the following:	
AS 402	Air Science and Tactics	(4-1)4
EN 402	Textile Applications of Electricity	(1-4)1
EN 420	Industrial Instrumentation	(2-3)3
EN 432	Advanced Textile Testing	(1-3)2

Textile Manufacturing

This course of study is designed to equip students with a well-rounded understanding of the theory and principles of fundamental manufacturing processes. All common commercial fibers, regardless of whether they are animal, vegetable, mineral, or man-made are studied.

This course covers a detailed study of such topics as source, availability, properties, uses, characteristics, and the methods of manufacture of fibers, and the operations or processes of marketing, grading, sorting, and other preparatory steps.

It also covers the theory involved and application of fundamental manufacturing processing, such as fiber processing, yarn manufacture, fabric design, weaving, knitting, dyeing, finishing, testing, and evaluation.

The broad purpose is to prepare students as competent Textile Manufacturing Technologists for eventual supervisory, administrative or executive positions. It is felt that this can best be done by a single comprehensive course that covers the basic theory, principles and applications of all phases of textile manufacturing with all fibers and all processes.

This course leads to a B.S. degree and hence, such fundamental studies as mathematics, physics and chemistry are naturally included. However, a maximum amount of time is devoted to textile and such engineering subjects as are essential to a textile manufacturing technologist.

The Humanities are included to provide a well-rounded education and to develop the student's ability to clearly express himself to others, as well as to give him an understanding of human behavior so that he may deal wisely with people.

Any student completing this course of study should be well qualified to ultimately assume a position of responsibility in any phase of the textile manufacturing industry.

The following curriculum is applicable to the entering Freshman (Class of 1958) Class. The programs in Course I—Cotton Manufacture, Course II—Wool Manufacture, Course III—Textile Design, and Course V—Synthetic Textiles, which will be applicable to the Sophomore (Class of 1957), Junior (Class of 1956), and Senior (Class of 1955) Classes, are listed in the Appendix.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	102	General Inorganic Chemistry	(2-3)3
EN	114	Engineering Drawing	(0-3)1
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(2-2)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	19
*Alternate:			
GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	203	Elementary Organic Chemistry	(3-0)3
EN	205	Mechanism	(3-2)4
MA	205	Mathematics	(3-0)3
PH	201	Physics	(3-2)4
TE	201	Textile Fibers	(4-0)4
		Total credit hours	20
*Alternate:			
GS	205	Man and His Environment	(3-0)3

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
EN	352	Statistical Methods	(3-0)3
PH	202	Physics	(3-2)4
PH	204	Optical Instruments	(3-2)4
TE	202	Textile Fibers	(3-0)3
TE	204	Yarn Manufacture	(3-6)5
		Total credit hours	21
*Alternate:			
GS	210	Speech	(2-0)2

JUNIOR YEAR

First Semester

EN	311	Heat and Power	(2-2)3
GS	201	Economics	(3-0)3
TE	301	Yarn Manufacture	(5-12)9
TE	303	Fabric Manufacture	(1-3)2
*Electives			3 or 4
		Total credit hours	20 or 21
*Electives:			
AS	301	Air Science and Tactics	(4-1)4
		A General Studies subject	(3-0)3

Second Semester

CH 302	Introduction to Textile Chemistry	(1-3)2
EN 304	Textile and Electronic Instrumentation	(2-2)3
GS 202	Economics	(3-0)3
TE 302	Yarn Manufacture	(3-6)5
TE 304	Fabric Manufacture	(2-3)3
*Electives		3 or 4
	Total credit hours	19 or 20

*Electives:

AS 302	Air Science and Tactics	(4-1)4
	or	
GS 352	Elements of Marketing	(2-0)2
	and	
GS 212	Business English	(1-0)1

SENIOR YEAR

First Semester

CH 401	Introduction to Textile Chemistry	(1-3)2
GS 301	Economic Development of the United States	(3-0)3
TE 401	Fabric Manufacture	(4-6)6
TE 403	Textile Evaluation	(2-2)3
TE 405	Textile Finishing	(2-3)3
*Electives		3 or 4
	Total credit hours	20 or 21

*Electives:

AS 401	Air Science and Tactics	(4-1)4
	A General Studies subject	(3-0)3

Second Semester

GS 314	Philosophy of Science	(3-0)3
TE 402	Fabric Manufacture	(5-9)8
TE 404	Textile Evaluation	(2-2)3
TE 406	Textile Finishing	(2-3)3
*Electives		3 or 4
	Total credit hours	20 or 21

*Electives:

AS 402	Air Science and Tactics	(4-1)4
	A General Studies subject	(3-0)3

Textile Sales and Management

This course is designed for those interested in the marketing and management phases of the textile and allied industries. Its emphasis is on all three branches of management—production, distribution, and finance.

The student is given a fundamental knowledge of the natural sciences and their application to the processing of all types of textile fibers. This scientific and manufacturing background is increasingly essential to effective merchandising and management, particularly at the higher levels of supervision.

A substantial amount of time is also devoted to cultural subjects designed to broaden the student's outlook, increase his understanding of social and economic problems, and improve his ability to get along with people.

The following curriculum is applicable to the entering Freshman (Class of 1958) Class. The program for the Sophomore (Class of 1957), Junior (Class of 1956), and Senior (Class of 1955) Classes will be found in the Appendix.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS 102	Air Science and Tactics	(2-1)2
CH 102	General Inorganic Chemistry	(2-3)3
EN 114	Engineering Drawing	(0-3)1
EN 122	Machine Tool Laboratory	(1-2)1
GS 112	English Composition and Readings	(2-2)3
MA 102	College Mathematics	(3-2)4
PH 102	Physics	(4-2)5
	Total credit hours	19

*Alternate:

GS 102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS 201	Air Science and Tactics	(2-1)2
CH 203	Elementary Organic Chemistry	(3-0)3
GS 201	Economics	(3-0)3
MA 205	Mathematics	(3-0)3
PH 201	Physics	(3-2)4
TE 203	Textile Fibers	(4-0)4
	Total credit hours	19

*Alternate:

Elective approved by Division Head

Second Semester

*AS 202	Air Science and Tactics	(2-1)2
EN 352	Statistical Methods	(3-0)3
GS 202	Economics	(3-0)3
GS 206	Man and His Environment	(3-0)3
PH 202	Physics	(3-2)4
TE 206	Yarn Manufacture	(3-3)4
	Total credit hours	19

*Alternate:

Elective approved by Division Head

JUNIOR YEAR

First Semester

GS 311	Economic Statistics	(3-0)3
GS 321	Marketing Principles and Practices	(3-0)3
GS 341	Accounting I	(3-0)3
TE 307	Yarn Manufacture	(3-3)4
TE 309	Fabric Manufacture	(2-2)2
*Elective		3 or 4
	Total credit hours	18 or 19

*Electives:

AS 301	Air Science and Tactics	(4-1)4
	Elective approved by Division Head	(3-0)3

Second Semester

CH 302	Introduction to Textile Chemistry	(1-3)2
GS 322	Marketing Principles and Practices	(3-0)3
GS 342	Accounting II	(3-0)3
TE 308	Yarn Manufacture	(3-3)4
TE 310	Fabric Manufacture	(3-3)4
*Elective		3 or 4
	Total credit hours	19 or 20

*Electives:

AS 302	Air Science and Tactics	(4-1)4
	Elective approved by Division Head	(3-0)3

SENIOR YEAR

First Semester

GS 303	Psychology	(3-0)3
GS 343	Principles of Selling and Advertising	(3-0)3
GS 461	Personnel Management	(3-0)3
GS 463	Business Law	(3-0)3
TE 403	Textile Evaluation	(2-2)3
TE 405	Textile Finishing	(2-3)3
*Elective		3 or 4
	Total credit hours	21 or 22

*Electives:

AS 401	Air Science and Tactics	(4-1)4
	Elective approved by Division Head	(3-0)3

Second Semester

GS 302	Modern Labor Problems	(3-0)3
GS 412	Industrial Management	(3-0)3
GS 466	Management Problems	(3-0)3
GS 468	Business Finance	(2-0)2
TE 404	Textile Evaluation	(2-2)3
TE 406	Textile Finishing	(2-3)3
*Elective		3 or 4
	Total credit hours	20 or 21

*Electives:

AS 402	Air Science and Tactics	(4-1)4
	Elective approved by Division Head	(3-0)3

Student in Electronics Laboratory

Operating Control Board for Grating Spectrograph

Old Number		*New Number*	
COTTON	301–302	TE	313–314
COTTON	311	TE	317
COTTON	322	TE	318
COTTON	401	TE	417
COTTON	402	TE	418
DES.	101 or 102	TE	101 or 102
DES.	122	GS	122
DES.	251–252	TE	217–218
DES.	406	TE	422
DES.	411–412	TE	411–412
DES.	413 or 414	TE	413 or 414
ECO.	201–202	GS	201–202
ECO.	311	GS	311
ECO.	321–322	GS	321–322
ECO.	341	GS	341
ECO.	342	GS	342
ECO.	344	GS	344
ECO.	351	GS	351
ECO.	412	GS	412
ECO.	421	GS	421 or 422
ECO.	468	GS	468
ENG.	102	EN	203
ENG.	104	EN	204
ENG.	351	EN	351 or 352
ENGL	101–102	GS	111 and 112
ENGL	201 or 202	GS	209 or 210
ENGL	211 or 212	GS	211 or 212
ENGL.	222	GS	222
FIN.	401–402	TE	423–424
FIN.	411	TE	409
FIN.	421	TE	421
FIN.	432	TE	408
GER.	201–202	GS	261–262
GER.	301–302	GS	361–362
KNIT.	401	TE	419
KNIT.	403	TE	407
KNIT.	412	TE	426
MATH.	103–104	MA	101–102
PHYS.	101	PH	102
SOC.SCI.	101–102	GS	101–102
SOC.SCI.	212	GS	226
SOC.SCI.	222	GS	206
SOC.SCI.	223 or 224	GS	223 or 224
SOC.SCI.	301	GS	301
SOC.SCI.	302	GS	302
SOC.SCI.	311	GS	303
SOC.SCI.	314	GS	314
SOC.SCI.	401 or 402	GS	401 or 402
SOC.SCI.	461	GS	461
SOC.SCI.	463	GS	463
SOC.SCI.	465 or 466	GS	465 or 466

Old Number		*New Number*
SYN.	302	TE 320
SYN.	312	TE 312
SYN.	411–412	TE 427–428
TEX.	302	TE 300
TEX.	311–312	TE 403–404
WOOL	211–212	TE 211–212
WOOL	301–302	TE 315–316
WOOL	321–322	TE 321–322
WOOL	411	TE 415

AIR SCIENCE

AS 101-102 Air Science and Tactics I (2-1)(2-1)4

Introduces the AFROTC cadet to the history of aviation and its development into the jet air-age. Provides the student with a fundamental knowledge of global geography and acquaints him with the international tensions and security structures of various nations of the world. Leadership and Drill provides for the development in the student of the qualities of leadership and discipline essential to Air Force officers and acquaints him with the fundamentals of drill.

AS 201-202 Air Science and Tactics II (2-1)(2-1)4

Weapons, targets, types of aircraft, the air ocean, bases, and the USAF combat and support organizations. The USAF Officer Career Program is explained and a leadership laboratory is conducted in Officer Training.

AS 301-302 Air Science and Tactics III (4-1)(4-1)8

Aircraft engineering, navigation, weather, military law, correspondence, problem-solving techniques, self-expression. Leadership laboratory.

AS 401-402 Air Science and Tactics IV (4-1)(4-1)8

Seminar in leadership and personnel management. The framework of international politics; world powers and strategic areas; the security problem in relation to international power clashes. Principles of warfare and a historical survey of air warfare. Briefing for commissioned service and a leadership laboratory.

CHEMISTRY

CH 101 **General Inorganic Chemistry** **(5-3)6**

The basic principles of chemistry and a consideration of non-metallic elements and their compounds.

CH 102 **General Inorganic Chemistry** **(2-3)3**
[CH 101]

Metals and their compounds.

CH 104 **General Inorganic Chemistry** **(2-0)2**
[CH 101]

Metals and their compounds, with emphasis on the chemical principles involved rather than on the descriptive matter.

CH 121 or 122 **Qualitative Analysis** **(1-6)3**
[CH 101]

The systematic qualitative analysis of inorganic compounds through the use of semi-micro technique.

CH 124 **Elementary Stoichiometry** **(2-0)1**
[CH 101 and MA 103]

The elementary calculations of inorganic chemistry and qualitative analysis.

CH 201-202 **Organic Chemistry** **(3-3)(3-3)8**
[CH 102 or 104]

The classification, structure, mechanism of reaction, and behavior in bulk of certain organic molecular species. Emphasis is given to the properties of organic substances of possible importance in industries based upon the use of organic polymers, such as the textile, paper, leather and plastic industries. The laboratory work attempts to illustrate properties of some of the classes of organic substances together with some of the techniques employed in organic laboratory operations.

CH 203 **Elementary Organic Chemistry** **(3-0)3**
[CH 102]

This subject enables students not majoring in chemistry to become conversant with the names, structural formulas, properties and uses of some important industrially-available organic substances and with the role which organic chemistry plays in industry and engineering.

CH 204 **Chemical Technology of Fibers** **(2-0)2**
[CH 201]

The chemical properties of the textile fibers and the reactions with chemicals and dyes which are of technical importance. Both natural and artificial fibers are considered.

CH 211-212 **Quantitative Analysis** **(2-6)(2-6)8**
[CH 104, 122 and 124]

The fundamental principles of quantitative chemical analysis. One lecture hour per week is devoted to the calculations of analytical chemistry. The first semester (CH 211) is devoted to the principles of gravimetric analysis, including the separations involved in mineral samples as well as the analysis of soluble salts. The second semester (CH 212) is devoted to the volumetric techniques involved in neutralization methods; permanganate, dichromate, and cerate oxidimetry; and iodimetry.

CH 213 or 214 **Quantitative Analysis** **(2-6)4**
[CH 112 and 124]
CH 214 not offered in 1954–1955

This subject is designed to present the principles and techniques of gravimetric and volumetric analysis for non-chemistry majors. The gravimetric portion stresses the fundamentals involved in the analysis of soluble salts; the volumetric methods include acidimetry-alkalimetry, oxidation-reduction, and iodimetry.

The lecture hours are devoted to a study of the underlying principles and mathematical calculations involved in the laboratory operations.

CH 302 **Introduction to Textile Chemistry** **(1-3)2**
[CH 102]
Not offered in 1954–1955

Lectures for the non-chemist on the various processes preliminary to dyeing. The preliminary treatments given the natural and manufactured fibers are studied as well as the action and properties of the textile chemicals used in these processes.

CH 311 **Textile Quantitative Analysis** **(1-3)2**
[CH 212]

The examination of materials used in the textile mill, the dyehouse, and the finishing plant. Emphasis is placed on the practical techniques employed in the standard methods for analyzing and evaluating bleaching agents, industrial water, soaps, and oils.

CH 312 **Textile Quantitative Analysis** **(1-3)2**
[CH 311]

A continuation of the practical techniques studied in CH 311. The examination of vegetable, animal, and lubricating oils; sulfated oils; and synthetic detergents.

CH 321 **Textile Chemistry** **(2-3)3**
[CH 202, EN 104, PH 202]

This subject is designed primarily for those majoring in chemistry and is the first of four semesters of work relating to the chemistry of all

types of textile fibers, i.e., cotton, wool, rayon, nylon, and synthetics. Lectures are given on operations preliminary to dyeing and on the physical organic chemistry of dyes. Operations preliminary to dyeing are carried out in the laboratory.

CH 322 Textile Chemistry (2-3)3
[CH 321]

A continuation of CH 321. The following topics are studied: water in the textile industry, theory of dyeing, coloring matters, and dyeing processes.

CH 331-332 Physical Chemistry (3-1½)(3-3)8
[CH 124, CH 212, MA 202 or 204, and PH 202]

The important principles of physical chemistry, i.e., gaseous, liquid, solid states; elementary chemical thermodynamics; determination of molecular weights; viscosity; surface tension; etc. Topics covered include dilute solutions, chemical equilibrium, phase equilibrium, free energy, and electrical properties of solutions.

CH 333 Industrial Stoichiometry (3-0)3
[CH 124, CH 213 and PH 201]

A study of some important operations in the chemical industry, e.g., sulfuric acid, and in the pulp and paper industry from the standpoint of the application of reaction rate, mass and energy balance to prediction of performance, yield, etc. Recirculatory processes will also be studied.

CH 342 Organic Qualitative Analysis (1-3)2
[CH 122 and 202]

The standard non-physical methods of identification of unknown samples of organic substances which have been previously reported in the chemical literature.

CH 352 Chemical Engineering (3-0)3
[CH 104, CH 331, MA 202 or 204, and PH 202]

Descriptive and quantitative information on unit conversion, dimensional analysis, materials of construction, flow of fluids, flow of heat, hygrometry, humidification, dehumidification, and drying.

CH 362 General Colloid Chemistry (2-0)2
[CH 331]

The basic general principles of colloidal chemistry, followed by elementary analyses of important problems encountered in amorphous materials such as paints, cellulosic products, leather, paper, and textiles.

CH 364 Textile Colloid Chemistry (4-0)4

[CH 331]

Basic principles of surface and colloidal chemistry and their applications in industry. Special emphasis is placed on applications to the textile field: wetting, detergency, and finishing processes, as well as the colloidal behavior of the fibers themselves.

CH 401 Introduction to Textile Chemistry (1-3)2

[CH 302]

Not offered in 1954–1955

A continuation of CH 302. The application of various classes of dyes to natural and manufactured fibers. Methods of dyeing, fastness properties of different classes of dyes, the nature and use of dyeing assistants.

CH 411-412 Advanced Textile Chemistry and Dyeing (2-9)(2-9)10

[CH 322]

A continuation of CH 321–322, covering: color matching and color combining; dye testing and evaluation; union dyeing; printing, and dye house management.

CH 414 Special Studies in Dyeing (1-3)2

[CH 412 or permission of instructor]

A subject designed for those desiring more than the required work in dye application. Further work in dye application is given, also dye testing, color matching, and textile printing.

If the student has a particular problem in the application of dyes, time will be allotted for its study.

CH 415 or 416 Theory of Dyeing (2-0)2

[CH 322]

Fundamental chemical and physical aspects of the dyeing of protein, cellulose, and synthetic fibers. Consideration is given to the reaction of dyes with fibers, effects on dyeing of chemical and physical variations in fibers, and of chemical and physical processing of fibers, and the effects of variations in industrial dyeing techniques.

CH 421 or 422 Advanced Chemical Textile Testing (2-3)3

[CH 212 and 364]

CH 421 not offered in 1954–1955

Chemical methods of textile testing. Quantitative as well as qualitative determination of fiber content, finishing agents and dyestuffs on the fiber, fiber damage, etc. Optical methods of analysis and evaluation.

CH 441 Advanced Chemical Engineering (3-0)3

[CH 352]

A continuation of CH 352. The unit operations of evaporation, gas absorption, filtration and washing.

CH 442 Chemical Engineering Thermodynamics (3-0)3
[CH 332]

A study of the first law of thermodynamics. Heat capacity, perfect gases, phase rule and generalized pressure, volume and temperature relations. An introduction to the second law.

CH 451-452 Organic Chemistry of Polymeric and Natural Amorphous Materials (3-0)(3-0)6
[CH 202, 321, and 332]

The classification, mechanism of formation, structure and properties of polymeric materials arising from organic monomers. The reactions of naturally occurring amorphous materials such as the polysaccharides and proteins, with emphasis given to those which aid in the determination of structure or modify the properties of such materials to make them more useful for textile, paper, leather, and plastic industries.

CH 461 or 462 Microbiology (1-3)2
[CH 202]

This subject considers the fundamentals of mycological and bacteriological theory briefly but in sufficient detail so that the problem of the microbiological deterioration of textiles, paper, and leather may be discussed.

Methods of detecting mildewing, methods of testing textiles for mildew resistance and bacteriological water analysis are also studied.

CH 464 Advanced Microbiology (1-3)2
[CH 461 or 462]

Work is arranged according to the interests of the individual student. Laboratory exercises such as the identification of pure cultures, the comparison of commercial mildewproofing agents, etc. are typical.

CH 472 Inorganic Preparations (2-3)3
[CH 104]

The reactions and processes of inorganic chemistry which are more used in commercial practice than in the laboratory. Experiments are chosen in conference between student and instructor.

CH 473 The Theory of Atomic and Molecular Structure (2-0)2

A discussion of the old theory of atomic structure precedes the topic of wave mechanics and its application to atomic and molecular structure. The following topics are presented: the hydrogen atom; the periodic classification of the elements; the covalent bond; saturation and direction of valency bonds; resonance; method of molecular orbitals, and complex compounds. In addition, about a fourth of the subject is spent on the hydrogen bond and the theory of acids and bases.

CH 474 Advanced Inorganic Chemistry (2-0)2

The element hydrogen; the oxygen, nitrogen, carbon and boron families; the alkali and coinage metals; the alkaline earth metals; the zinc family and the transitional elements. Where possible, applications of inorganic materials to the leather, paper, and textile industries will be introduced.

CH 475 or 476 Special Studies in Physical Chemistry (1-3)2
[CH 331–332]

Open to seniors and graduate students who have shown interest and aptitude for physical chemistry.

An opportunity for those especially interested in the methods of physical chemistry to do further work in the laboratory. Preference will be given to those who wish to investigate the application of recent techniques which may be applied in industry.

Laboratory work and conferences as arranged with instructor.

CH 481 or 482 Tracer Techniques (1-3)2
[Permission of Instructor]

The use of radioactive substances as tracers. In the laboratory the fundamental techniques of counting, Feather analysis, "hot lab." syntheses, radioautographs, etc., are covered. The safe handling of radioactive materials at the microcurie level will be stressed.

CH 491 Textile Chemistry Literature Seminar (2-0)2
[Permission of Instructor]

A study and discussion of current textile chemistry literature, stressing the critical analysis of the subject matter.

CH 501 or 502 Color Measurement for Textile Chemists Credits and hours to be arranged
[CH 421 or equivalent]

The operation and use of transmission and reflection colorimeters, spectrophotometers, and recording spectrophotometers is studied by means of lectures and laboratory experiments. The calculation of results and the use of the instruments in dye application research are also investigated.

CH 503 Interpretation of Data (2-0)2

Mathematical methods of analyzing, plotting and interpreting experimental data, which lead to properly weighted quantitative results, are studied by means of lectures and exercises.

CH 505 Physical Chemistry of Dyeing (2-3)3

A combination of lectures, seminars, and laboratory experiments on the physico-chemical principles involved in the application of dyestuffs to textile materials.

CH 511 or 512 The Physical Chemistry of Surface Acting Agents (1-3)2

[CH 364]

A series of lectures and laboratory experiments on the physico-chemical principles involved in the use of surface-active agents in textile processing. The surface and bulk properties of the agents are studied and related to the over-all technical properties and uses.

CH 516 Chemical Thermodynamics (2-02)

Lectures on the principles of thermodynamics and their applications to chemical and physical problems.

CH 521 or 522 Textile Testing Problems Credits and hours to be arranged

[CH 421]

Special problems relating to the design and evaluation of improved analytical or testing procedures.

CH 525 or 526 Evaluation of Finishing Agents Credits and hours to be arranged

[TE 312]

A laboratory study designed to teach the use of the various test methods and instruments in evaluating the effect of finishing treatments on the tactile and end-use properties of a fabric.

CH 527 Instrumental Methods in Textile Research (1-2)2

The use of instruments in textile chemical research. The lectures cover the general principles of instrumentation in the various fields considered. The laboratory exercises invoke the use of specific instruments and are designed to teach the student to make a proper choice of instrumental methods in common textile chemical problems.

CH 531-532 Textile Chemistry Seminar (2-0)(2-0)4

A series of informal discussions of current problems in research and technology in the textile chemistry field. Special investigations of the literature will be utilized to serve as a source of seminar topics.

CH 541-542 Graduate Thesis Credits to be arranged

The graduate thesis is to be an independent investigation of a problem by the student in conference with a faculty advisor and approved by the Department Head. A clear and systematic written presentation of the results is a required part of this subject.

ELECTRONICS

EL 201-202 Introductory Circuit Theory (3-0)(3-0)6

[MA 106 and PH 104; MA 207–208 and PH 205–206 taken concurrently]

An introduction to the study of the mathematical and physical aspects of electric circuits in which radiation in the form of electromagnetic waves does not play a major role. Resistive circuits, Kirchoff's laws, Thevenin's theorem, reciprocity theorem, superposition theorem, impedance concept, impulse and step function response of simple circuits, sinusoidal steady-state behavior, vector diagrams, resonance, transients in alternating current circuits, loci of complex functions, polyphase systems, and an introductory discussion of simple non-linear circuits.

Text: Guillemin, *Introductory Circuit Theory.*

EL 203-204 Elementary Electricity and Magnetism Laboratory (0-3)(0-3)2

[PH 104; EL 201–202 taken concurrently]

The purpose of this subject is to give the student a working knowledge of the use of common electrical devices and measuring equipment as well as practice in the preparation of circuit drawings, the writing of technical reports and the analysis of the precision of measurements. Some attention will be given to the practical techniques useful in the construction of electrical equipment and accessories. Among the topics considered in the laboratory are: measurements of resistance, capacitance, inductance and impedance; DC and AC bridge circuits; magnetic measurements; characteristics of vacuum tubes and other non-linear devices; elementary vacuum tube circuits; AC and DC motors, and transformers.

EL 301-302 Introduction to Physical Electronics (3-0)(3-0)6

[EL 202 and MA 208]

Not offered in 1954–1955

The motion of charged particles in electric and magnetic fields, electronic phenomena in metals, statistical electron theory of metals, characteristics of thermionic cathodes, kinetic theory of gases, fundamental processes in gases, electrical discharges in gases, rectifiers and filters, photoelectricity, diodes, gas tubes, photoelectric cells, triodes and multielectrode tubes.

Text: Millman and Seely, *Electronics.*

EL 303-304 Electronic Circuits (3-0)(3-0)6

[EL 202 and MA 208; EL 301–302 taken concurrently]

Not offered in 1954–1955

Characteristics of electronic tubes; graphical solutions for circuits containing non-linear elements; linear equivalent circuits; combina-

tions of resistive, capacitive and inductive elements; response of basic circuits to simple wave forms; amplifiers; oscillators; clamping, clipping, and trigger circuits; voltage regulating circuits; multivibrators and counting circuits.

EL 305-306 Electronics Laboratory (0-4)(0-4)4

[EL 202, EL 204 and PH 206; EL 303–304 taken concurrently]

Not offered in 1954–1955

The purpose of this subject is to give the student a good working knowledge of a number of electronic circuits and the techniques of measurement for evaluating their performance. A number of these circuits are assembled by the student. Further training is provided in the analysis and reporting of experimental work. Development of the student's initiative, resourcefulness and independent judgment is encouraged.

EL 307-308 Electromagnetic Devices and Machinery (3-0)(3-0)6

[EL 202, MA 208, and PH 206; MA 301–302 taken concurrently]

Not offered in 1954–1955

Dimensional analysis, free and forced response of dynamic systems, electromechanical analogies; electromagnetic, piezoelectric, magnetostrictive, electrothermal and electromechanical devices; indicating and recording equipment, electrical computers, and fractional horsepower motors.

EL 309-310 Instrumentation and Electromagnetics Laboratory (0-4)(0-4)4

[EL 202, EL 204, and PH 206; EL 303–304 taken concurrently]

Not offered in 1954–1955

The purpose of this course is to familiarize the student with the construction and operation of various electromechanical devices and motors encountered in practice. Some attention will be given to the study of the dynamic performance of these devices. The preparation of carefully written technical reports will be encouraged.

EL 401-402 Industrial Electronics and Servomechanisms (3-0)(3-0)6

[MA 302 and EL 304]

Not offered in 1954–1955

A survey of industrial electronic control systems. Among the topics considered are: selsyns, amplidynes, regulators, servomechanisms, magnetic amplifiers, saturable reactors, inverters, high-current rectifiers, and high-voltage machines.

EL 403-404 Communication and Microwave Electronics (3-0)(3-0)6

[MA 302 and EL 304]

Not offered in 1954–1955

Practice in the analysis of electronic systems. Beginning with zero frequency circuits, a study is made of the modifications required to give proper behavior as the frequency is increased. Among the topics considered are: radio frequency circuits, television circuits; amplitude, frequency, and pulse modulation; elements of electromagnetic theory, antennas, waveguides, microwave generators and receivers.

EL 405-406 Introduction to Solid State Electronics (3-0)(3-0)6

A broad survey of solid state electronics. Elements of crystal physics; elastic thermal and electrical properties of crystals; piezoelectricity; elements of the wave theory of matter; energy levels in solids; band theory of solids; Brillouin zones; Fermi-Dirac statistics; electron theory of metals; thermal and ionic diffusion; thermionic emission; field emission; electrical contacts; semi-conductors; rectification; transistor physics; insulators; radiation and atomic structure, photoelectricity and photoconductivity, secondary emission; magnetic, paramagnetic, and diamagnetic properties of solids; ferro- and ferrimagnetism; ferroelectricity; surface phenomena; adsorption, and catalysis.

EL 407-408 Experimental Electronic Techniques (1-0)(1-0)2

Not offered in 1954–1955

Vacuum tube construction, vacuum technology, the metallurgical and mechanical properties of some metals, glass working, glass-to-metal seals, welding and soldering, phosphor and semiconductor technology, high-temperature properties of materials, behavior of materials at high frequencies, miniaturization of components, reliability of components, and the fabrication of electronic components.

EL 409-410 Electronic Projects Laboratory (0-4)(0-4)4

[EL 306 and 310]

Not offered in 1954–1955

In this subject the student is given the opportunity to develop, construct, study, modify, and test electronic components and systems. It is expected that he will carry out his investigations more or less independently. Original investigations will be encouraged but not required. The careful preparation of technical reports on the experimental work will be emphasized. Where practicable, the student will be expected to write his reports using the style of either the *Journal of the Institute of Radio Engineers* or the *Review of Scientific Instruments.*

EL 411-412 Applied Electronics Laboratory (0-4)(0-4)4

[EL 306 and 310]

Not offered in 1954–1955

The purpose of this subject is to give the student an experimental familiarity with the nature, application and performance of various electronic devices. Emphasis is given to the preparation of good technical reports.

EL 501-502 Seminar in Electronics (1-0)(1-0)2

Discussion by staff members and students of current journal publications and topics of current interest in electronic science, electronic engineering and related areas of applied physics.

EL 503-504 Intermediate Solid State Electronics (3-0)(3-0)6

[EL 406]

Not offered in 1954–1955

An intensive study of selected topics in solid state electronics.

Text: Shockley, *Electrons and Holes in Semiconductors.*

EL 505-506 Electronic Control and Measurement (3-0)(3-0)6

[EL 304 or equivalent]

Not offered in 1954–1955

The basic principles of electronic devices used for control and measurement in applied science and engineering.

EL 507-508 Transients in Electromechanical Systems (3-0)(3-0)6

[MA 302 or equivalent]

Not offered in 1954–1955

Training in the formulation and solution of ordinary and partial differential equations which arise in the treatment of mechanical, acoustical, thermal and electrical systems. Extensive use is made of modern operational mathematical techniques.

Text: Gardner and Barnes, *Transients in Linear Systems.*

EL 509-510 Microwave Electronics (3-0)(3-0)6

[EL 404]

Not offered in 1954–1955

Elements of electromagnetic theory, transmission lines, impedance matching, waveguides, antennas, microwave oscillators and amplifiers, klystrons, magnetrons, and travelling wave tubes.

EL 511-512 Electromagnetic Theory (3-0)(3-0)6

[PH 412]

Not offered in 1954–1955

Maxwell's equations, stress and energy, the electrostatic field, the magnetostatic field, plane waves in isotropic media, cylindrical waves, spherical waves, radiation, and boundary value problems.

Text: Stratton, *Electromagnetic Theory.*

EL 513-514 **Special Problems in Electronics** **Credits and hours to to be arranged**

The purpose of this subject is to give the student an opportunity for individual study, under the direction of a staff member, of topics in or related to electronic engineering.

EL 515-516 **Graduate Research** **Credits and hours to be arranged**

Not offered in 1954–1955

Supervised research on some problem in electronic science, electronic engineering, or in certain areas of applied physics. The results of the research are to be embodied in a thesis acceptable to the departmental committee on graduate study.

ENGINEERING

EN 111 **Engineering Drawing** **(0-6)2**

Freehand and mechanical drawing, including lettering, geometric construction, orthographic projection, isometric and cabinet drawing, and dimensions.

EN 112 **Engineering Drawing** **(0-6)2**

[EN 111]

A continuation of EN 111 which includes the following topics: auxiliary views, cross sections, advanced dimensioning, sketching of machine parts, working drawings, tracing and blueprinting, intersections, and developments.

EN 113 **Engineering Drawing** **(0-3)1**

An abbreviation of EN 111.

EN 114 **Engineering Drawing** **(0-3)1**

[EN 111]

A continuation of EN 111 and abbreviation of EN 112.

EN 122 **Machine Tool Laboratory** **(1-2)1**

The objective of this subject is to give the student an insight into the processing of metals through lectures and practical laboratory applications covering the basic machine tools such as the lathe, shaper, drill-press, and milling machine, and also the uses of measuring instruments, threads, and gears. Lectures and demonstrations cover topics such as pattern work, foundry practice, die-casting, welding, and forging.

EN 201 **Machine Drawing** **(0-3)1**

[EN 112]

Several short problems involving centers of gravity, counterweights, cam layouts, piping, welding, sheetmetal drafting, and assembly drawings.

EN 203 **Mechanism** **(3-0)3**

The basic principles of kinematics, in which the wide variety of process machinery available furnishes many specific examples. Frequent use of these mechanisms is made in the development of the subject. Some of the important topics covered are the following: rolling cylinders and cones, gearing, gear train design, epicyclic gear trains, flexible connectors including stepped pulley and cone design, cam design, linkages, and miscellaneous mechanisms.

EN 204 **Mechanism** **(2-0)2**

Not open to students in the Textile Engineering course

An abbreviation of EN 203, designed for those students not majoring in engineering.

EN 205 **Mechanism** **(3-2)4**

[PH 102]

Not offered in 1954–1955

Similar to EN 203, except that laboratory time has been provided to allow study of textile mechanisms.

EN 220 or 221 **Textile Mechanism** **(1-2)2**

[EN 102 and 112]

The graphical and mathematical analyses of advanced mechanism found in textile machinery. The forces in, and velocities of, the various members of the mechanism are determined from actual data taken from the machines by the student himself.

EN 222 or 223 **Applied Mechanics** **(3-0)3**

[MA 201, taken concurrently if necessary, and PH 102]

The fundamentals of statistics and kinetics, including such topics as force systems, laws of equilibrium, centers of gravity, moments of inertia, analysis of stresses in framed structures, momentum, energy, work and power, and the dynamics of the translation and rotation of rigid bodies.

EN 233 **Machine Tool Laboratory** **(0-3)1**

A continuation of EN 122, giving practical and more detailed instruction in such operations as lay-outs, filing, drilling, planing and shaping, and placing special emphasis on precision work.

EN 301-302 **Advanced Applied Mechanics** **(3-0)(3-0)6**

[EN 222 and MA 202]

Strength of materials, including such topics as simple stresses, strain, bending moments, shearing force, slopes and deflections in beams, beam design, torsion, and design of shafts.

The work of the second semester deals with continuous beams, compound beams and columns, eccentric loading, combined stresses, reversals of stress, impact stresses, vibrations, and stress analysis by strain gage methods.

EN 304 **Textile and Electronic Instrumentation** **(2-2)3**

[PH 202]

Not offered in 1954–1955

A study of indicating and recording instruments used to measure such common textile process variables as pressure, temperature, humidity, liquid level, fluid flow, etc. An introduction also to electronic circuitry as it relates to textile processing instrumentation controls.

EN 311 **Heat and Power** **(2-2)3**

[PH 201]

Not open to students in the Textile Engineering course

Not offered in 1954–1955

Similar to EN 403 but briefer and designed for those not majoring in engineering.

EN 312 **Heat Engineering** **(3-2)4**

[MA 202 and PH 201]

The principles of elementary thermodynamics, the properties of steam, mechanical mixtures, and combustion of fuels.

EN 321 **Strength of Materials** **(3-0)3**

[MA 201 and PH 102]

A more elementary and condensed treatment of EN 301–302.

EN 331 **Mill Engineering** **(3-0)3**

[EN 222]

The various types of building construction in the textile industry, including details of construction from a study of actual blueprints, calculation of allowable floor loads, stresses in beams and columns, machinery layout and the use of the transit in elementary surveying.

EN 332 **Engineering Materials** **(2-0)2**

[PH 201]

The manufacture, properties, and uses of important ferrous and non-ferrous metals; hot and cold processing, alloying, heat treatment; also the properties and use of non-metallic engineering materials such as timber, cement, concrete, rubber, plastic, and mechanical fabrics.

EN 342 **Principles of Electrical Engineering** **(3-2)4**

[PH 321]

At the beginning of this subject polyphase circuits are considered. The greater part of the subject, however, is devoted to direct-current generators and motors with a study of their construction and characteristics. The accompanying laboratory work illustrates the various methods of measuring polyphase power and of determining the characteristics of direct-current generators and motors.

EN 344 **Electrical Machinery** **(3-2)4**

[PH 321]

A condensation of EN 342 and EN 401.

EN 351 or 352 **Statistical Methods** **(3-0)3**

[MA 201 or 203, and MA 205]

The fundamental statistical measures and methods required for the analysis of experimental data; also the practical applications of statistical analysis to quality control and to the planning of industrial experiments.

EN 401 Principles of Electrical Engineering (3-2)4
[EN 342]

A detailed study of the three-phase circuit and the alternator, with particular stress on generation of three-phase currents. Methods of predetermination of alternator regulation are taken up and at least one method is compared with a laboratory test. Parallel operation of alternators with accompanying instruments and devices are studied in classroom and laboratory. The single-phase and three-phase transformers are considered in turn, and their various methods of connecting to line and alternators are systematically discussed. The induction motor and generator are studied with reference to their particular adaptability to the textile industry and the principal starting devices for the motor are covered in detail. The synchronous motor is studied particularly in relation to its ability to correct power factor.

EN 402 Textile Applications of Electricity (1-4)1
[EN 344 or 401]

The applications of electricity used by the textile industry including study of the commercial color analyzers, illumination of textile plants, static and lint eliminators, electronic rectifiers for motor control, range drives, electronic heating and drying, stop motions, scanning devices, and electronic relays. Trips are made to local mills to see the equipment in actual operation.

EN 403 Principles of Heat Engineering (3-2)4
[EN 203, MA 202 and PH 201]

The basic principles of thermodynamics, properties of steam and its utilization in manufacturing processes, and the combustion of fuels. A brief treatment of steam engines, turbines and pumps is also included. Special consideration is given to the use of steam in manufacturing. processes.

EN 411 Advanced Heat Engineering (2-2)3
[EN 312]

The kinematics of stationary steam generating units, reciprocating engines, steam turbines, pumps, condensers, and internal combustion engines. Special attention is given to the use of steam for processing purposes in industry.

EN 420 Industrial Instrumentation (2-3)3
[PH 201 and 202]

Similar to EN 422 with the addition of three hours of laboratory per week.

EN 422 Industrial Instrumentation (2-0)2
[PH 201 and 202]

Modern methods of measurement and control of the more common process variables such as temperature, pressure, liquid level, fluid flow, etc.

The subject matter is divided into three parts. The first part is devoted to a study of the measurement of process variables using mechanical, electric and electronic instruments, and of their response characteristics. The second part covers an analysis of the modes of control and associated mechanical and electrical mechanisms used to control automatically the measured variable. The characteristics of final control elements are also studied at this time. Finally the closed-loop control system is analyzed. Stress is placed upon process characteristics and their effect upon the selection of the correct mode of control.

EN 424 — Machine Design — (2-2)3

[EN 302 or 321]

The design of machine elements, such as fasteners, shafts, frames, bearings, gears, clutches, springs, keys and drives. Data for most of the problems are taken from actual machines in the various laboratories.

EN 425-426 — Engineering Design of Textile Structures — (2-0)(2-0)4

[Permission of Instructor]

This subject correlates engineering properties of textile materials, engineering principles, and textile processing in the design of textile structure with desired properties. The subject matter is presented in two major divisions. The first deals with the geometry of yarns and fabrics, and the extent to which it is possible to design the dimensions of a textile structure for a certain functional use or to predict the dimensional changes which will occur during such use. The second division deals with the design from the standpoint of the stresses, strains, and energy changes which the end-use imposes, and is based upon the information supplied by analyses of load-elongation diagrams of the textile structural material.

EN 431 or 432 — Advanced Physical Textile Testing — (1-3)2

[TE 312]

EN 432 not offered in 1954–1955

This subject is arranged to provide a more extensive background in the measurement and evaluation of the physical properties of textile materials. Some of the topics studied are: compression testing, engineering properties of fibers and yarns, stress-strain-time phenomena of visco-elastic materials, theory and operation of strain gage testing machines, methods of measurement of yarn evenness, thermal transmission, flexibility of fabrics, fabric friction, bursting stress, and crimp. The use of the microscope, as a tool of textile testing, is emphasized by the inclusion of appropriate experiments. Wherever possible the laboratory experiments are arranged to develop confidence in the use of the customary methods of statistical analysis of data and to acquire familiarity with new ones.

EN 502 **Statistical Quality Control** **(3-0)3**
[EN 351 or 352]

A study of the various types of control charts for maintaining quality of manufactured products and of the several types of sampling plans for the reduced inspection of manufactured products and of raw materials. Applications of the foregoing statistical techniques to industry in general are discussed, with special emphasis on their application to the textile and other industries.

EN 503 or 504 **Air Conditioning** **(2-2)3**
[PH 201]

The fundamental principles of heating, ventilating, and refrigeration. The laboratory consists of design problems in the air conditioning of industrial buildings.

EN 505-506 **Methods of Experimental Stress Analysis** **(3-1)3**
[MA 202, PH 201 and 202, EN 302]

An introduction to some of the experimental techniques used in stress analysis. Photoelasticity, electrical strain gages, brittle coating, and mechanical gages are considered in relation to the analysis of both static and dynamic stresses. Special attention is given to the application of these techniques in the study of textile structures and machinery.

EN 507 or 508 **Fluid Mechanics** **(3-0)3**
[MA 202 or 204; PH 201]

Properties of fluids; statics of fluids; flotation; relative equilibrium; dynamics of fluids, Bernoulli's theorem, measurement of velocity and pressure; cavitation; flow of viscous fluids; Reynolds' number; flow in pipes; flow with free surface; critical depth; weirs; orifices and nozzles; impulse and momentum in fluids; resistance of immersed and floating bodies. Froude's number, boundary layer; dynamics of compressible fluids, Mach's number; dynamical similitude and Pi theorem.

EN 509-510 **Advanced Statistical Methods** **(3-0)3**
[EN 351 or 352]

A continuation of EN 351 or 352 with particular study of the more advanced statistical techniques as applied to the design of industrial experiments and to the analysis and interpretation of the resulting data.

EN 511-512 **Graduate Thesis** **Credits to be arranged**

Each graduate student in Textile Engineering is required to submit a thesis which shows ability and originality in the solution of a research project.

GENERAL STUDIES

GS 101-102 World Economic Geography (2-0)(2-0)4

Through a study of this subject the student gains an appreciation of the economic status of the different geographic areas of the world. It has been shown that the climate, the geographic structure, and the distribution of important raw materials have an effect upon the activities of the people inhabiting those areas and on the types of industry which support the economic life of the various regions.

GS 111 English Composition (2-2)3

Thorough training in the fundamental rules of correct expression, grammatical principles, sentence and paragraph construction, and vocabulary development. A written theme is assigned each week.

GS 112 English Composition and Readings (2-2)3

A practical application of the principles studied in GS 111. The student is trained to express himself with clarity and accuracy and to think creatively when he is reading. Weekly assignments in an omnibus of essays and the writing of themes based on the outside readings or on other topics are required.

GS 122 Perspective Drawing (1-2)2

This subject equips the student with a mechanical method of representation. Through the study of vanishing points and measuring points the student learns to represent on a two-dimensional surface, objects of three dimensions showing correct proportions as they appear to the eye.

GS 201-202 Economics (3-0)(3-0)6

The principles and practices of economics and a brief study of economic history.

GS 205 or 206 Man and His Environment (3-0)3

The biological aspects of fundamental problems of heredity and environment which confront man in his economic, social, and cultural life. Emphasis is given particularly to the fields of ecology, genetics and eugenics, evolution, and anthropology.

GS 209 or 210 Speech (2-0)2
[GS 112]

The aim of this subject is to achieve effective delivery of various types of speech. All kinds of delivery—extemporaneous, impromptu, memorized, etc.—are studied and analyzed.

GS 211 or 212 — Business English — (1-0)1

[GS 112]

Analysis and practice in letter writing and a study of the basic forms of technical exposition, forming a background for report writing in advanced courses and in industrial activity.

GS 222 — Appreciation of Literature — (2-0)3

[GS 112]

The principles of literary appreciation and criticism. The prose and the poetry studied will be treated analytically, with directed investigation of the various literary appeals—the intellectual, the sensory, the emotional, the aesthetic, the imaginative, and the philosophical. Emphasis will also be placed upon the value of an extensive reading program.

GS 223 or 224 — The United States Since 1865 — (3-0)3

When requested by a sufficient number of students

A survey of the advancement of the American people from the Reconstruction Era through World War II. The agrarian problem, rise of big business, expansion of America into a world power, World War I, and the depression are some of the topics that will be discussed from the political, social, and economic viewpoint.

GS 226 — World History Since 1900 — (3-0)3

The content of this subject will concern the two-decade intermission, 1919–1939, with attention to such factors as the rise of new states; the origin and development of new concepts of nationalism, racism, and other phenomena; and the final alignment of world powers for World War II. The emphasis in the latter part of the subject will be upon the role of the United States in mid-twentieth century reconstruction.

GS 261-262 — Technical German — (3-0)(3-0)6

The basic elements of German, leading to the development of reading ability in scientific German.

GS 301 — Economic Development of the United States — (3-0)3

An intensive study of current developments in the American economy, with emphasis in such fields as security, welfare, labor unionism, labor economics, ownership and management of industry, and trends in government regulation. Lectures, selected readings, and case material will be utilized.

GS 302 — Modern Labor Problems — (3-0)3

The subject will involve the use of a manual of current labor laws which apply in Labor-Management relationships in the United States. Case material will be studied to familiarize the students with Federal and State court actions, rulings of the National Labor Relations Board,

and the functions of both public and private conciliators and arbitrators. At intervals during the semester, the class will meet informally with representatives of both Labor and Management, and opportunities will be provided for discussion of important points with the visiting speakers. The chief objectives of this study will be (1) a proper consideration of the important current issues in collective bargaining and (2) the development of familiarity with the techniques of the bargaining table and the problems in drafting, interpreting, and administering the modern labor contract.

GS 303 — Psychology — (3-0)3

The place of psychology in the life of the individual and society. Physiological bases of behavior and experience, attention, perception, memory, thinking, emotions, intelligence, and personality in terms of the whole person in his social setting.

GS 311 — Economic Statistics — (3-0)3

Basic concepts of the statistical method with special emphasis on those approaches of most interest to the student of management. Topics covered include: measures of central tendency, graphic methods, dispersion, skewness, sampling, normal curve, index numbers, correlation, time series, secular trend, seasonal variation, business cycle, and statistical forecasting.

GS 314 — Philosophy of Science — (3-0)3

This subject analyzes the methods and techniques of inductive and deductive science. Elementary logic is studied and applied to the necessary structure of scientific systems. The great concepts and generalizations which have marked the history of science are reviewed and analyzed, as well as the interrelation of science and general philosophy.

GS 321-322 — Marketing Principles and Practices — (3-0)(3-0)6

GS 321 is an introduction to the basic principles underlying the modern systems of distributing goods with special emphasis on the raw and finished products of the textile industry. This subject will cover the history and economic importance and the functions in modern distribution of the selling agent, the commission man, the broker, jobber, merchant, factor, and other intermediaries. It will also consider the channels that goods may take from the producer to the ultimate consumer. The importance and advantages of each will be studied with special emphasis on the present practice and trends in the textile industry.

GS 322 is a continuation of GS 321. Some of the topics studied are: economic aspects of fashion, branding, sales promotion and advertising, market research, analysis of distribution costs, forecasting, market potentials, price policies, legal aspects of marketing, vertical integration, sales planning and control and the complete campaign.

GS 341 Accounting—I (3-0)3

The economic significance of accounting, the underlying accounting theories, and the organization and use of modern accounting records. The preparation and interpretation of reports and statements of financial position. The balance sheet, profit and loss statement, theory of debits and credits as applied to journalizing, and the usage of the various ledgers. Cost accounting methods and systems as applied to industry.

GS 342 Accounting—II (3-0)3

This subject is designed to further acquaint the student with accounting practice, emphasis here being placed on partnership and corporate records. Special emphasis will be given to payroll and tax accounting in addition to work dealing with installment and branch accounting techniques. The peculiar aspects of manufacturing accounting will be covered in detail, with the application of cost principles to this area.

GS 343 Principles of Selling and Advertising (3-0)3

The fundamental principles of advertising and salesmanship. Topics covered include: psychology of selling and advertising, copy writing, layout, printing and engraving, testing and research, planning an advertising campaign, government restrictions, types of media, radio advertising, trademarks, building a selling talk, fundamentals of salesmanship, types of personal selling, personality, retail salesmanship, training, etc.

GS 351 or 352 Elements of Marketing (2-0)2

GS 352 not offered in 1954–1955

A condensation of the more important elements of marketing covered in GS 321–322, designed to give the student an understanding of marketing as it affects wholesaling, retailing, and the consumer. Market research, advertising, branding, and vertical integration will also be considered.

GS 361-362 Advanced Technical German (3-0)(3-0)6

[GS 262 or equivalent]

GS 361 may be taken without continuing GS 362

This subject is designed to expand the student's elementary understanding of the language, to increase vocabulary, and to develop reading aptitudes in special fields of interest selected by the student.

GS 401 or 402 Industrial Relations Seminar (2-0)2

[Permission of Instructor]

This subject will give a small, selected group opportunities to meet with the instructor and occasional visitors in discussion of current problems in industrial relations. Case material and hypothetical problems in modern labor management will provide the basis for the study by the group.

GS 412 Industrial Management: Principles and Problems (3-0)3

Backgrounds of modern industry; organization of the industrial enterprise; the operation of modern industry; and coordination of the productive processes. Among the topics covered are: risks, forecasting, financing, product development, plant layout, production controls, personnel management, time and motion studies, job evaluation, and wage and salary administration. The text material is supplemented with current readings and case material.

GS 421 or 422 Foreign Trade (3-0)3

[GS 202]

The growth and development of foreign trade, international commercial policies, transportation and communication facilities, and international finance. A good portion of the semester's work will be devoted to a study of the practical aspects of exporting and importing. Examples will be given in the textile field wherever possible and actual documents relating to foreign trade will be exhibited and used in regular class work.

GS 461 Personnel Management (3-0)3

A comprehensive study of modern labor management techniques in the recruiting, selection, training, and placement of members of the work force. Major emphasis is placed upon the development and maintenance of personnel administration agencies and procedures with the framework of present-day American industry, with special attention to such matters as employee health and safety, welfare and recreation programs, wage and salary administration, training and education, and management relations with labor organizations.

In addition to text material and selected readings, problems will be drawn from actual cases for study and solution by the students. Every effort will be made to acquaint the class with current personnel administration practices in industrial organizations of various types, and to give an appreciation of the importance and magnitude of the labor management function.

GS 463 **Business Law** **(3-0)3**

The basic principles of commercial law. Topics studied include: contracts, agency, sales, partnerships, corporation, negotiable instruments, bailments and carriers, insurance, personal property, real property, suretyship and guarantee, and bankruptcy.

GS 465 or 466 **Management Problems** **(3-0)3**

[Permission of Instructor]

Research for graduate students and selected seniors. Working under the guidance of the instructor, a student investigates an approved topic in the fields of finance, production, or distribution. The findings of the student are presented in formal thesis form. These theses will then be placed in the department library for permanent record.

GS 468 **Business Finance** **(2-0)2**

The organization and financing of private enterprise, partnership, trust, and corporate types of business establishments. The stock and bond markets. Emphasis will be placed on the study of the corporation in formation, operation, dissolution, and reorganization.

LEATHER

LE 202 **Applied Leather Analysis** **(1-4)2**

[CH 213]

A subject designed to acquaint the student with the accepted methods of analysis of the American Leather Chemists Association and other supplementary procedures.

LE 301-302 **Leather Manufacture** **(3-6)(3-6)10**

Introduction to the technology of leather manufacture. The first semester is devoted to examining government regulations in imported hides and skins, studying the purchasing of hides and skins, and classifying various hide damages. This is followed by work on the handling of raw stock at the tannery, unhairing, bating, and hide classification. The second semester is concerned primarily with the study of vegetable tanning, chrome tanning, and various other types of tanning. In the work throughout the year the material covered in lectures is supplemented by laboratory studies on a small scale.

LE 303 **Leather Histology** **(3-3)4**

[CH 201–202]

A study of the structures of animal skin and of the changes which they undergo in the leather-making process. Because the basically extracellular nature of skin demands it, considerable time will be devoted to the nature and function of the fundamental protein constituents.

LE 304 **Advanced Leather Histology** **(3-3)4**

[LE 303]

A study of the fibers of leather in their relationship primarily to the mechanisms of tanning and secondarily to pathological situations and to the physical characteristics of leather.

LE 401-402 **Leather Manufacture** **(3-6)(3-6)10**

[LE 302]

A continuation of the study into the technology of leather manufacture covering the various currying treatments applied to rough leather such as fat liquoring, stuffing, dyeing and the various mechanical operations of setting, stretching, etc. It is intended to show how widely the physical properties of leather may be varied and controlled by the proper application and selection of these numerous operations and treatments.

LE 404 **Properties of Leather** **(2-3)3**
[EN 351 and LE 401]

A practical and theoretical study of the characteristics of leather in relation to the end use. Studies will be made on measuring and classifying the effect of changes in manufacturing procedure, both chemical and physical. Leather, because it is a natural product, varies considerably within the same hide. Thus, the nature of this variation is very important and the study of any changes affecting it is, in turn, important.

LE 405 **Leather Seminar** **(1-0)1**

A seminar on recent advances in leather research. Written and oral reports will be required, and time will be devoted to techniques of proper presentation of these reports.

LE 406 **Leather Seminar** **(1-0)1**

A continuation of LE 405.

LE 411-412 **Leather Problems** **(1-6)(1-6)6**
[LE 302]

This subject is designed primarily to enable the student to put into practical application the various scientific principles of physics, chemistry, mathematics, economics, etc. on problems of an industrial nature. This may encompass anything from the design and layout of any of a number of special leather plants to the suggested solution of practical problems which arise in the operation of a modern leather business.

MATHEMATICS

MA 101-102 College Mathematics (3-2)(3-2)8

The work in the first semester consists of algebra and plane trigonometry. Algebra is reviewed through quadratics and then logarithms, simultaneous equations, and the theory of equations are studied. In plane trigonometry, the solution of right and oblique triangles is reviewed and trigonometric identities and equations are taken up. Instruction in the use of the slide rule is given and the use of approximate data is discussed.

In the second semester the following topics are considered: the straight line, equations of various curves, differentiation of algebraic functions.

MA 106 Elementary Engineering Mathematics (5-0)5

[A grade of B or higher in MA 101]

An intensive study of the geometric properties and equations of curves, and the elements of differential and integral calculus. Stress is placed on the application of mathematics to problems in engineering. Topics studied include: graphical representation of functions; differentials and derivatives of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic and hyperbolic functions; integration of algebraic, trigonometric, exponential, and hyperbolic functions; analytic geometry of the straight line and conic sections; polar coordinates and parametric representation.

Texts: Thomas, *Calculus and Analytic Geometry;* Pierce, *A Short Table of Integrals.*

MA 201-202 Analytic Geometry and Calculus (4-0)(4-0)8

[MA 102]

In the first semester the following topics are treated: maximum and minimum values, rates and differentials, the circle, parabola, ellipse, hyperbola, indefinite integrals, summation by integration, and applications of integration. In the second semester the topics treated are: differentiation of transcendental functions, methods of integration, solid analytic geometry, polar coordinates, partial differentiation, and empirical formulas.

Commencing in 1955–1956, credits will be (3–0)(3–0)6.

MA 204 Mathematics for Chemists (4-0)4

[MA 201]

Exponential, logarithmic, and trigonometric functions; measurements and computation rules; properties of logarithmic equations; triangular graphs; semi-logarithmic and logarithmic graphs; exponential growth and decay; curve fitting; chemical applications of differential equations; partial derivatives.

Commencing in 1955–1956, credits will be (3–0)3.

MA 205 **Mathematics** **(3-0)3**

[MA 102]

Not offered in 1954–1955

Applications of differentiation and integration, construction of nomographic charts, and the derivation of empirical equations.

For students not majoring in chemistry or engineering.

MA 207 **Intermediate Engineering Mathematics** **(4-0)4**

[MA 106]

A continuation of MA 106. Methods of integration, elementary vector analysis, elements of solid analytic geometry, partial differentiation, multiple integrals, infinite series, and the elements of complex variable theory. Stress is given to the application of the mathematics to problems in applied science and engineering.

Texts: Same as in MA 106.

MA 208 **Differential Equations for Engineers** **(3-0)3**

[MA 207]

A general survey of ordinary differential equations and an introduction to partial differential equations and the Laplace transformation. Numerous applications are made to problems in physics, chemistry and geometry.

MA 301-302 **Advanced Calculus for Engineers** **(3-0)(3-0)6**

[MA 208]

Ordinary differential equations, Laplace transformation, numerical methods of solving differential equations, series solutions of differential equations, boundary value problems and orthogonal functions, vector analysis, partial differential equations, partial differential equations of mathematical physics, and complex variable theory.

Text: Hildebrand, *Advanced Calculus for Engineers*.

MA 402 **Differential Equations** **(3-0)3**

[MA 202 or 204]

A review of series and partial differentiation, first- and second-order differential equations, and first- and second-order partial differential equations. The practical applications illustrated are designed for the chemist and the engineer.

MA 501 **Vector and Tensor Analysis** **(3-0)3**

Not offered in 1954–1955

The algebra of vectors, differential vector calculus, differential geometry, integration, tensor analysis and Riemannian geometry. Frequent applications are made to problems in mechanics, hydrodynamics, elasticity, and electricity.

Text: Lass, *Vector and Tensor Analysis*.

MA 502 **Matrix and Tensor Analysis** **(3-0)3**

Not offered in 1954–1955

Matrix and tensor analysis and their applications to problems in engineering and physics.

MA 503 **Complex Variables** **(3-0)3**

[MA 206]

Not offered in 1954–1955

Complex numbers, series expansions of analytic functions, residues and poles, contour integration, conformal mapping, Schwarz-Christoffel transformations, analytic continuation, Riemann surfaces, and multi-valued functions. Emphasis is given to topics considered most essential to physics and engineering.

MA 504 **Fourier Series and Boundary Value Problems** **(3-0)3**

Not offered in 1954–1955

The theory of Fourier series and its application to the solution of boundary value problems. Bessel functions, Legendre polynomials, and Fourier integrals.

Text: Churchill, *Fourier Series and Boundary Value Problems.*

MA 505-506 **Modern Operational Mathematics** **(3-0)(3-0)6**

Not offered in 1954–1955

Applications of the Laplace transform technique to the solution of ordinary and partial differential equations with special reference to those which arise in the analysis of electrical circuits, mechanical vibrations, heat conduction, and automatic control problems.

MA 507-508 **Methods of Applied Mathematics** **(3-0)(3-0)6**

[MA 302]

Not offered in 1954–1955

The aim of this subject is to give the student a working knowledge of a number of facts and techniques relevant to the following topics: matrices, determinants, linear equations, linear vector spaces, characteristic-value problems; calculus of variations, Hamilton's principle and Lagrange's equations; difference equations; integral equations, Green's function, analytical and numerical methods for obtaining solutions of integral equations.

Text: Hildebrand, *Methods of Applied Mathematics.*

MA 509 or 510 **Graphical Mathematics** **(0-6)2**

[EN 112 and MA 202]

Graphical solutions in algebra, differential and integral calculus, and in space geometry, with analytical verification; nomographs.

PAPER

PA 301-302 Pulp and Paper Manufacture (3-0)(3-0)6

[CH 102]

Lectures on the production and technology of pulp and paper.

PA 303 Pulp Manufacture, Testing and Analysis (2-6)4

[CH 213]

An elementary study of the principal woods and pulping methods used in pulp manufacture. The lecture work is accompanied by laboratory training in wood and pulp microscopy, pulping techniques, and pulp testing and analysis.

PA 312 Paper Manufacture, Testing and Analysis (2-6)4

[CH 213]

An elementary study of the fundamental processing techniques used in paper manufacture. The lecture work is accompanied by laboratory training in paper making, paper testing and analysis, and paper microscopy.

PA 401-402 Practice Work in Industry (1-8)(1-8)8

[PA 302 and 312, or equivalent]

In order to give the student as thorough a knowledge of industrial problems and practices as possible, it is planned, in cooperation with several mills and converting plants, to set up practice stations. The student will spend one full day each week at one of these stations working on technical problems of interest to the mill management, but under the supervision of a member of the Institute staff. May be taken either or both semesters.

PA 403 Materials of Construction, Corrosion 2 credits

[PA 401 taken concurrently]

This subject, given at the practice stations, covers the common construction materials used in the industry and their ability to stand up under various conditions of use. It will be illustrated by examples in the plants studied.

PA 405 Paper Converting Laboratory (2-6)4

[PA 302 and 312]

Study and practice in the use of some of the common techniques employed in the paper converting industry. The laboratory work is designed with a research-type approach in an effort to develop the student's ability in planning his work.

PA 407 **Paper Coating and Converting** **(3-0)3**

[PA 312]

Coating, treating and impregnating, laminating, embossing, and creping will be treated and, if time permits, printing.

PA 408 **Mill Inspection** **(1-4)2**

[PA 302 and 407]

Mill visits involving the observation of operations in various types of paper mills and converting plants. A formal report on each visit is required.

PA 412 **Industrial Cellulose Chemistry** **(1-0)1**

[CH 202]

The manufacture and use of the chief cellulose derivatives will be reviewed. In addition, various chemical treatments for cellulose in the paper and textile fields will be discussed.

PA 414 **Advanced Paper Problems** **(2-6)4**

[PA 303 and 312]

This is designed to give the senior an opportunity to work upon a problem connected with some phase of the paper or paper converting industry. Problems will be selected by the student and staff in collaboration.

PA 501-502 **Graduate Thesis** **Credits to be arranged**

Every graduate student is required to prove his ability to carry on independent research by presenting a thesis on an approved subject.

PA 503-504 **Advanced Paper Microscopy** **(2-6)(2-6)8**

A study of the microscopic techniques and use of accessory equipment. Emphasis is on special papermaking and converting materials in process. Special attention is given to finished and converted products and their uses. The course includes identification, distribution (mechanical and structural) and chemical effects. There is room for wide latitude of study, depending on student's interest.

PA 505-506 **Advanced Papermaking and Paper Converting** **(2-6)(2-6)8**

This subject deals mainly with the non-fibrous raw materials used in the specialty papermaking and paper-converting fields. Emphasis will be placed on recent developments and new uses. These materials will be studied with regard to their chemical and physical properties, the technology of application and processed sheet properties.

PHYSICS

PH 102 **Physics** **(4-2)5**

The basic principles of mechanics, including the following topics: vector analysis, equilibrium of concurrent forces, equilibrium of non-current forces, rectilinear and curvilinear motion, inertia, harmonic motion, moment of inertia, conservation of energy, simple machines, hydrostatics and elements of hydraulics.

PH 103 **Elementary Engineering Physics** **(4-0)4**

Required for students who intend to major in Electronic Engineering but also open to others.

Composition and resolution of vectors, statics, moments, center of gravity, rectilinear motion, Newton's second law, motion of a projectile, work and energy, impulse and momentum, circular motion, rotation, elasticity, harmonic motion, hydrostatics, hydrodynamics and viscosity.

Text: Sears and Zemansky, *College Physics.*

PH 104 **Elementary Engineering Physics** **(5-0)5**

[A grade of B or higher in MA 101 and PH 103]

An intensive subject for students who wish to major in Electronic Engineering. Topics include: response of matter to temperature changes, conduction of heat, first and second laws of thermodynamics, wave motion and sound, electrostatics, direct-current circuits, magnetism, alternating-current circuits, electronics, optics, elements of atomic and nuclear physics.

Text: Same as in Ph 103.

PH 201 **Physics** **(3-2)4**

[PH 102]

A continuation of PH 102. Thermometry, measurement of heat, change of state, expansion, transfer of heat, humidity, magnetism, electrostatics, fundamental laws of direct and alternating current circuits, motors and generators, and electronics.

PH 202 **Physics** **(3-2)4**

[PH 102]

Sound, light, and modern physics. Some of the topics are: wave motion, velocity of sound, characteristics of musical sounds, acoustics, reflection and refraction of light, lenses, optical instruments, color sensation, double refraction and polarization, and elements of nuclear physics.

PH 204 Optical Instruments (3-2)4

[PH 202 taken concurrently]

Not offered in 1954–1955

The basic laws of optics and their application to various optical instruments used in industry, such as the microscope, telescope, refractometer, and colorimeter. Considerable emphasis in the laboratory work is placed on the general use of the microscope.

PH 205-206 Intermediate Engineering Physics (3-0)(3-0)6

[MA 106 and PH 104; MA 207–208, taken concurrently]

The fundamental laws of electricity and magnetism presented from the point of view of field theory. Free use is made of the calculus. Topics in the first semester include: electrostatics, steady currents and their magnetic fields, induced electromotive forces and inductance, elementary alternating current circuits, and time dependent magnetic fields. In the second semester the following topics are studied: electromagnetic waves in free space, on wires, and in material bodies; behavior of electrons in metals, thermionic emission, dielectric and magnetic properties of matter, geometrical optics, physical optics, atomic structure and topics in modern physics.

Text: Frank, *Introduction to Electricity and Optics*, 2nd edition.

PH 321 Electronics *Tex. Eng.-Eng. Opt.* **(3-2)4**
Others **(3-1)3**

[PH 201]

The principles of alternating currents as a background for the understanding of electronic circuits. The elements of vacuum and gaseous tube characteristics and of circuits containing such tubes for the purpose of rectification, amplification, and oscillation. Industrial photoelectric relays, time delay relays, and Thymotrol motor controls.

PH 401 Textile Microscopy (1-3)2

[PH 202]

Applications of the microscope to textile materials. Methods of sectioning, measurement of cotton immaturity and mercerization, determination of denier of rayon, wool grading, fiber identification, quantitative analysis of fiber mixtures and their practical applications. Some of the more advanced aspects of critical microscopy which are essential for the best visual work and photographic practice are considered. Some time is devoted to photographic work and the use of polarized light.

PH 402 Textile Physics (2-3)3

[MA 201 or 205; PH 201 and 202]

Textile Physics is designed primarily for graduate students but may be taken by seniors who have sufficient knowledge of elementary college physics, microscopy and testing. It deals in an analytical and

experimental manner with the principles of advanced physics which have important applications to textile technology. The topics taken up include heat transmission of textile materials; color measurements; calculation of tristimulus values; transformation to dominant wave-length, colorimetric purity and brightness; measurement of refractive index of fibers; applications of phase microscopy; fluorescent microscopy; use of X-ray diffraction methods to determine crystal orientation and structure of fibers; spectrographic analysis; investigation of mineral elements in textile fibers; accurate methods of measuring stress, strain, viscosity, etc.

PH 411-412 Advanced Engineering Physics (3-0)(3-0)6

[MA 302 or permission of instructor]

Not offered in 1954–1955

The aim of this subject is to present a unified view of the various fields of classical physics and to show their relation to engineering.

PH 501 or 502 The Physics of Color Measurement Credit and hours to be arranged

[MA 202 or 204 and PH 202]

The philosophy and practice of modern colorimetry. Topics covered include: colorimeters, their uses and limitations, spectrophotometers, tristimulus values, dominant wave-length and purity, the "standard observer" concept, the Munsell system, the Ostwald system, color tolerances, gloss and body color, illuminants, and industrial applications.

Laboratory instruments available consist of brightness testers, monochromatic and trichromatic colorimeters, recording and visual spectrophotometers.

PH 503-504 Spectrographic Methods (1-3)(1-3)4

[PH 202]

The theory and application of the spectrograph for the qualitative and quantitative analysis of materials. Topics covered include: the Bohr theory, quantum mechanics, atomic models, and the theoretical prediction of line and band spectra. Special attention is placed in the laboratory on the analysis of trace elements in textile materials and individual problems are assigned to the students.

PH 505 or 506 X-Ray Diffraction (1-3)2

[PH 202]

The theory of X-ray diffraction and its application to the structure of matter. Special consideration is given to the taking and interpretation of diffraction data obtained from fibers used in paper and textile technology.

PH 507 or 508 — Electron Microscopy — (1-3)2

[TE 404]

Basic methods in the practice of electron microscopy including specimen preparation, use and operation of the electron microscope, vacuum techniques, and photography. This work is supplemented with special studies on selected topics.

PH 509-510 — Solid State and Modern Physics For Engineers — (3-0)(3-0)6

Elements of electronics, special theory of relativity, atomic structure of matter, quantum mechanics, x-rays, molecular structure and molecular spectra, low-temperature phenomena, natural and induced radioactivity, nuclear fission, cosmic rays and mesons, elements of crystal physics, specific heats, alloys of metals, elastic and plastic properties of solids, rupture and fatigue of solids, thermal diffusion, electron theory of metals and alloys, thermal and electrical properties of solids, energy levels in solids, cohesion in solids; magnetic, paramagnetic and diamagnetic properties of solids; magnetic moments and resonance, transistor physics, semi-conductors and electron diffusion in metals.

Texts: Van Name, *Modern Physics;* Kittel, *Solid State Physics.*

PH 513-514 — Elementary Quantum Mechanics — (3-0)(3-0)6

Not offered in 1954–1955

The postulational formulation of quantum mechanics. The basic theory is developed both in the operator and matrix formulations.

PH 515 — Thermodynamics and Kinetic Theory — (3-0)3

Not offered in 1954–1955

The first, second, and third laws of thermodynamics, thermodynamic functions, chemical thermodynamics, thermodynamics of multicomponent systems, equations of state; elementary kinetic theory, mean free path, thermal conductivity, viscosity, and transport phenomena.

Text: Allis and Herlin, *Thermodynamics and Statistical Mechanics.*

PH 516 — Kinetic Theory and Statistical Mechanics — (3-0)3

Not offered in 1954–1955

A continuation of PH 515. In addition to some topics in the kinetic theory of liquids and solids, the following are considered: entropy and probability, Maxwell-Boltzmann statistics, equipartition of energy, quantum statistics, and degenerate gases.

Text: Same as in PH 515.

TEXTILES

TE 101 or 102 Elementary Textile Design (2-1)2

The classification of fabrics, use of point or design paper, plain fabrics, intersection, twills and their derivation, sateen, basket and rib weaves, checks, stripes, fancy weaves including figured and colored effects; producing chain and draw from the design, and vice versa; extending and extracting weaves.

TE 201-202 Textile Fibers (4-0)(3-0)7

Not open to members of the Textile Engineering Course

Not offered in 1954–1955

A study of the important textile fibers, both natural and man-made. Classifications, origins, production, grading, marketing, and consumption. Stress is placed on their basic physical and chemical properties and their relationship to processing and utilization.

TE 203 Textile Fibers (4-0)4

Not open to members of the Textile Manufacturing Course

Not offered in 1954–1955

Similar to TE 201–202, but less detailed.

TE 204 Yarn Manufacture (3-6)5

[TE 201]

Not offered in 1954–1955

The fundamental theory and practice of yarn manufacture by the cotton, woolen, worsted, and filament systems.

TE 206 Yarn Manufacture (3-3)4

[TE 203]

Not offered in 1954–1955

Similar to TE 204, but less detailed. Laboratory work consists of demonstrations only.

TE 211-212 Top Making (2-6)(2-6)8

[EN 102 and 112]

The preparation of wool and allied hair fibers for processing on all systems of manufacture. Special emphasis is placed on wool buying, grading, sorting, scouring and drying, carbonizing, burr picking, worsted carding, backwashing, gilling, Warner Swasey Pin Drafter, Holdsworth's Gill Reducer, Pacific Evenness Tester, Noble combing, tow to top conversion of synthetic fibers, Pacific Converter, top testing, and a study of classification of commercial tops.

TE 213-214 **Cotton Carding** **(3-2)(3-2)8**

[EN 102 and 112]

A study of the growth, classing, and handling of raw cotton and the processes of opening, picking, carding, combing, drawing and roving. Considerable time is devoted to the study of cotton production and characteristics so that the student may have a real appreciation of some of the processing problems originating in the cotton itself. Experiments and studies of the card room machinery are designed to acquaint the student with typical mill equipment and its use in processing commonly used cottons. The mill processes are studied in detail through specially prepared texts and illustrations. Emphasis is placed on the purposes and principles of each machine rather than on skill of operation.

TE 215 **Cottons** **(1-6)3**

[TE 213 taken concurrently, EN 102 and 112]

The economic importance of cotton is studied, and sources of information regarding cotton and its processing are given to the class. Some time is spent on the details of cotton fiber growth and structure. The commonly measured fiber characteristics are considered with a study of the tests and equipment more commonly used in measuring cotton fiber qualities.

Laboratory time is spent on cotton fiber study, processing and machinery studies supplementary to, and more detailed than, the work of TE 213.

TE 217-218 **Color** **(1-1)(1-1)4**

A study of color, value and chroma using the Munsell Color System. Several plates painted by the student show the application of color to textiles. These plates include perfected harmony and distribution in patterns illustrating stripes, checks, plaids, and decorative designs. The influence of colors upon one another is stressed to equip the student with a working knowledge which will aid him in his choice of color for the fabric in question.

Because of the extra home work required as a part of the laboratory, extra credit is allowed.

TE 222 **Cotton Waste Processing** **(1-6)3**

[TE 213, and TE 214 taken concurrently]

A survey of the methods and machinery used in processing cotton wastes or new cotton handled on waste machinery. The lectures consider the sources of the various wastes, their preparatory treatment, and the manufacturing processes.

Laboratory work includes the study of ordinary processing wastes,

their treatment in preparation for processing, and experiments on machinery used for yarn manufacture by the waste system.

Some ~~of this laboratory~~ time is also ~~used~~ to give additional instruction on regular carding, combing, drawing, and roving equipment.

TE 300 **Fabrics** **(2-0)2**

[TE 101 or 102]

This subject is designed to acquaint the student with many of the important fabric types in use today for wearing apparel, home furnishings, and industrial uses. An analytical discussion is used so that the student may not only identify the fabrics but also understand the significance of the weave, design, yarns, etc., used.

TE 301-302 **Yarn Manufacture** **(5-12)(3-6)14**

[TE 204]

Not offered in 1954–1955

A continuation of TE 204.

TE 303-304 **Fabric Manufacture** **(1-3)(2-3)5**

[TE 204, and TE 301–302 taken concurrently]

Not offered in 1954–1955

The fundamental theory and practice relating to the design, construction and analysis of commercial fabrics, regardless of the fibers and/or yarns involved. Weaving and knitting, with their allied processing operations.

TE 305 **Elements of Textile Manufacture** **(3-3)4**

Not offered in 1954–1955

The basic elements of fiber preparation, yarn manufacture by all systems, weaving, and knitting. Laboratory consists of demonstrations only.

TE 307-308 **Yarn Manufacture** **(3-3)(3-3)8**

[TE 206]

Not offered in 1954–1955

A continuation of TE 206.

TE 309-310 **Fabric Manufacture** **(2-2)(3-3)6**

[TE 203, and TE 307–308 taken concurrently]

Not offered in 1954–1955

An abbreviated version of TE 303–304 and TE 401–402. Laboratory work consists of demonstrations only.

TE 312 Structure and Properties of Synthetic Fibers (3-0)3

[CH 202 and PH 201]

The fundamental structure and properties of the manufactured fibers. The material is developed with the aim to relate the structures of the fibers to their properties and to lay the foundation for the more advanced work covered in TE 427–428.

TE 313-314 Cotton Spinning (2-3)(2-3)6

[TE 214]

A continuation of the study of yarn manufacture, covering the many types of regular and long draft spinning, spooling, winding and twisting machines and their products—plain and fancy yarns, threads, cords and ropes. Particular consideration is given to the production of yarns for different uses and to methods by which desired characteristics may be obtained. All the calculations regarding yarns, spinning frames, spoolers, winders, and twisters are thoroughly studied and problems are assigned for student practice. In the laboratory, standard industrial machinery is used to process fibers such as are commonly used in cotton mills.

TE 315-316 Woolen Yarns (2-4)(2-4)6

[TE 212 or WOOL 216]

Woolen system fiber blending, oiling, picking, carding, spinning, twisting, and the handling of reused and reprocessed fiber. Old rags and new clips are graded and sorted. Rag sources are covered as are rag picking, lumping, shredding, garnetting and complete manipulation from reprocessed clips and waste to fiber ready for carding and making into yarn. The processing of wool and synthetic fiber is studied in theory and practice. Special emphasis is given to details of woolen machinery, such as tape and ring doffer type condensers, broadband and Apperly intermediate feeds, automatic weighing feeders, peralta rolls, card drives, and modern mule and ring spinning.

TE 317 Staple Fiber Manufacture (1-2)2

[TE 313, taken concurrently if necessary]

Methods of manufacture of various staple fibers, such as wool, rayon, or the new synthetics, on regular or modified cotton machinery. Special attention to new developments.

TE 318 Cotton Quality Control (1-2)2

[TE 314, taken concurrently if necessary]

While it is customary to point out defects in the materials during the processing in all the lecture and laboratory work, this subject provides a logical summary of the usual defects which appear in different

stages of cotton manufacture. The student is taught to recognize defective work and is given the usual causes of the common defects. The usual procedures and methods necessary to avoid or correct the defects are explained. Many samples of defects are used to illustrate this subject. Every effort is made to develop the diagnostic ability of the student so that he may readily recognize and remedy defects as he meets them.

TE 320 **Throwing Plant Organization** **(2-0)2**
[SYN 301]

Plant organization, processing procedures, and quality control. Plant layouts from machinery viewpoints are discussed and assigned for study. Field trips to local plants are an integrated part of the class work.

TE 321-322 **Worsted Yarns** **(3-5)(3-3)9**
[TE 212 or WOOL 216]

Advanced gilling; French combing; top analysis and stapling; worsted yarn manufacture, including drawing, spinning, and twisting for both the English and French systems; colored blending of dyed wool tops, also blending wool top with other fibers. Gilling theories are demonstrated; French combing wool is processed into top on the French comb and both French and English system yarns are manufactured. Experiments are run on super draft drawing and spinning frames.

Considerable new equipment is available for laboratory work, as Whitin Super Draft Rover; Saco-Lowell FS-4 Rover and SS4 Spinning Frame; Whitin French Spinning Frame; six operation set French Drawing, etc.

TE 401-402 **Fabric Manufacture** **(4-6)(5-9)14**
[TE 304]
Not offered in 1954–1955

A continuation of TE 303–304.

TE 403-404 **Textile Evaluation** **(2-2)(2-2)6**
[CH 102 and MA 102]

This subject is designed to provide a foundation for more advanced work in testing, and is of sufficient breadth to benefit those students whose main need is an understanding and appreciation of the scope of testing and evaluation in the textile industry. The subject matter covers an applied approach to the statistical treatment of experimental data, and the basic mechanical or physical, chemical, and optical tools and techniques available to the industry for product control, development, and evaluation. Primary emphasis is placed upon an understanding of the principles involved and an integration of the various phases of textile testing into a unified whole.

TE 405-406 **Textile Finishing** **(2-3)(2-3)6**

[CH 302 and TE 304 or 310]

Not offered in 1954–1955

Lectures and pilot plant laboratory work in all major physical and chemical operations necessary for the conversion into the finished state of all fabrics commonly used, regardless of fiber content.

TE 407 **Knitting** **(2-3)3**

[EN 102 and 112]

Similar to TE 419, but with less laboratory work.

TE 408 **Cotton and Synthetic Finishing** **(3-3)4**

[CH 202 and TE 300]

Similar to TE 421, but stressing the chemical, rather than the physical, aspects.

TE 409 **Woolen and Worsted Finishing** **(3-3)4**

[CH 102 or 104]

An abbreviated version of TE 423–424.

TE 411-412 **Jacquard Design and Weaving** **(1-2)(1-2)4**

[Permission of instructor]

Weaving on the Jacquard loom and the various tie-ups in common use. Instruction includes the sketching of original designs as applied to particular fabrics. The student is taught to transfer his original sketch to cross section design paper, to choose the proper weave for both the background and foreground, to cut cards and lace, and to weave the fabric.

TE 413 or 414 **Jacquard Design** **(0-2)1**

[TE 101 or 102]

The student is taught to transfer a given motif to cross section paper, to choose the proper weave for the background and the foreground, and complete a Jacquard design. A sufficient number of cards are cut and laced to enable the student to appreciate the complete operation from the motif to the loom.

TE 415 **Woolen and Worsted Mill Organization** **(4-0)4**

[TE 316 and 322]

A recapitulation of the routine covered in previous wool textile manufacturing subjects. Mill layouts are organized to make definite yardages of specific fabrics using modern machinery by both the woolen and worsted system of manufacture.

TE 417 **Cotton Mill Organization** **(4-0)4**

[TE 314 or COTTON 304]

This subject correlates all of the work on cotton manufacturing. Starting with a study of actual mill organizations the class is carried forward to problems in developing new organizations for specific types of products. The adaptations for long draft and for the handling of staple fibers are carefully covered. Calculations are made for the machinery necessary to keep plants in balance with some consideration of the best arrangements for economical handling.

TE 418 **Management Problems** **(2-0)2**

[TE 417]

Supplementary to TE 417. Job descriptions, job assignments and work load studies. Some time is spent considering arrangement of machinery for practical routing and operation, auxiliary equipment necessary and materials handling problems for efficient manufacturing.

TE 419 **Knitting** **(2-5)4**

[Permission of instructor]

A broad survey of the important types of knitting. Considerable stress is placed on the various stitches and the characteristics of fabrics from each. Starting with flat machines, the work advances through small ribbers, automatic hosiery machines, full-fashioned hosiery machines, underwear machines and warp knitters. The production, design, and analysis of knit fabrics and the classifications and routines for manufacture of hosiery and underwear are included.

TE 421 **Cotton and Synthetic Finishing** **(3-3)4**

[CH 302 or CHEM. 222, and TE 300]

All the major physical and chemical operations necessary for the conversion into the finished state of staple gray cotton and synthetic fabrics are considered. In addition to inspection, singeing, desizing, padding, drying, calendering, curing, etc., the preliminary wet processing operations through dyeing are illustrated. Among the types of finishes employed are those of starching, softening, repelling, stabilizing, decating, etc., as well as the thermo-plastic and thermo-setting resins. The physical, rather than the chemical, aspects are stressed.

TE 422 **Advanced Textile Design and Analysis** **(2-1)2**

[Permission of instructor]

The first half of the semester is devoted to the study of Leavers Lace including history, manufacture, finishing, a detailed study of the Leavers machine, and the basic principles of lace design and drafting. The second half of the semester covers a study of embroideries and rugs. Schiffli embroidery includes the Schiffli machine, basic principles of

Schiffli design, manufacturing, finishing and types and end uses of embroidery. Rugs include a study of the principles of construction and the analyses of Chenille, Wilton, Brussels, Tapestry, Velvet, and Axminster carpets.

TE 423-424 Woolen and Worsted Finishing (2-3)(2-3)6

[CH 102]

A comprehensive introduction and orientation to the physical, rather than chemical, aspects of finishing including burling and mending, fulling, washing and speck dyeing, carbonizing, gigging, napping, steaming, singeing, crabbing, brushing, shearing, and pressing.

TE 426 Advanced Knitting (2-5)4

[TE 419]

This is an advanced subject for students who are specializing in knitting. With the approval of the department head, the student may select a particular field from the various sections of the knitting industry and concentrate on its problems.

TE 427-428 Properties and Applications of Synthetic Fibers (3-0)(3-0)6

[TE 312]

A continuation of TE 312. Much of the time will be spent on considerations of the fundamental properties of man-made fibers in relation to each other and to the behaviors of the finished textile resulting from these basic properties and the geometry imposed upon the fibers in the textile. To make the material more useful, comparisons are made with natural fibers and their textiles. Recent advances in the manufacture and study of fibers will be discussed.

TE 431 or 432 Advanced Weaving (2-3)3

[Permission of instructor]

Advanced work on the Crompton & Knowles looms, including the overhead multiplier, the filling mixer, and the tri-color automatic loom. Advanced work on the dobby looms, including Leno and Terry attachments. Other advanced areas such as Jacquard heads, harness mounting problems, and carpet weaving are also covered.

TE 501 or 502 Methods of Research (2-0)2

A seminar to familiarize the student with the philosophy and methods of research, current problems in textile research and the further use of textile literature.

TE 590-591 Thesis Research Credits and hours to be arranged

APPENDIX

As noted in previous sections, the Appendix lists the curricula for the Sophomore (Class of 1957), Junior (Class of 1956), and Senior (Class of 1955) Classes in all courses which are revised or superseded by new programs which will be initiated with the entering Freshman (Class of 1958) Class. In addition, the Appendix lists descriptions of subjects which are required or elective in these old courses but which will not be offered under the new curricula. These subjects retain former letter symbols.

Curricula listed in this Appendix are Course I, Cotton Manufacture; Course II, Wool Manufacture; Course III, Textile Design; Course IV, Textile Chemistry; Course V, Synthetic Textiles; Course VI-G, Textile Engineering—General Manufacturing Option; and Course VII, Textile Sales and Management.

Subject descriptions which cannot be found in this Appendix will be found under the previous section entitled "Subject Descriptions".

Course I — Cotton Manufacture

SOPHOMORE YEAR

First Semester				Second Semester			
*AS	201	Air Science	(2-1)2	*AS	202	Air Science	(2-1)2
GS	201	Economics	(3-0)3	DES.	222	Fabric Design	(2-1)2
MA	211	Mathematics	(3-0)3	GS	202	Economics	(3-0)3
PH	201	Physics	(3-2)4	MA	212	Mathematics	(3-0)3
TE	101	Elem. Tex. Des.	(2-1)2	PH	202	Physics	(3-2)4
TE	213	Cotton Carding	(3-2)4	TE	214	Cotton Carding	(3-2)4
TE	215	Cottons	(1-6)3	TE	222	Cot. Waste Proc.	(1-6)3
		Total Credit Hours	21			Total Credit Hours	21
*Alternate:				*Alternate			
DES.	261	Color	(1-1)1	GS	122	Perspective Drawing	(1-2)2

JUNIOR YEAR

CH	221	Intro. to Tex. Chem.	(2-0)2	CH	222	Intro. to Tex. Chem.	(1-3)2
DES.	223	Fabric Design	(2-1)2	GS	302	Mod. Labor Problems	(3-0)3
TE	313	Cotton Spinning	(2-3)3	TE	300	Fabrics	(2-0)2
TE	317	Staple Fiber Mfr.	(1-2)2	TE	314	Cotton Spinning	(2-3)3
TE	403	Tex. Evaluation	(2-2)3	TE	318	Cot. Qual. Control	(1-2)2
WEAV.	211	Weav. for Mfrs.	(2-2)2½	TE	404	Tex. Evaluation	(2-2)3
WOOL	311	Surv. of Wool Mfr.	(3-1)3	WEAV.	212	Weav. for Mfrs.	(2-2)2½
**Electives			3 or 4	**Electives			3 or 4
		Total Credit Hours	20½ or 21½			Total Credit Hours	20½ or 21½
**Electives:				**Electives:			
AS	301	Air Science	(4-1)4	AS	302	Air Science	(4-1)4
GS	301	Eco. Develop. of U.S.	(3-0)3	GS	210	Speech	(2-0)2
				GS	212	Business English	(1-0)1

SENIOR YEAR

COT.	411	Major Project	1	COT.	412	Major Project	6
GS	351	Elem. of Marketing	(2-0)2	FIN.	422	Cot. and Syn. Fin.	(0-3)1
TE	417	Mill Organization	(4-0)4	GS	412	Ind. Management	(3-0)3
TE	419	Knitting	(2-5)4	SYN.	322	Fil. Yarns Surv.	(2-0)1½
TE	421	Cot. and Syn. Fin.	(3-3)4	TE	418	Management Problems	(2-0)2
WEAV.	311	Weav. for Mfrs.	(2-2)2½	WEAV.	312	Weav. for Mfrs.	(2-2)2½
**Electives			4	**Electives			4
		Total Credit Hours	21½			Total Credit Hours	20
**Electives:				**Electives:			
AS	401	Air Science	(4-1)4	AS	402	Air Science	(4-1)4
COT.	411	Major Project	4	COT.	412	Major Project	4

Course II — Wool Manufacture

SOPHOMORE YEAR

First Semester				Second Semester			
*AS	202	Air Science	(2-1)2	*AS	202	Air Science	(2-1)2
DES.	232	Fabric Design	(2-1)2	DES.	233	Fabric Design	(2-1)2
GS	201	Economics	(3-0)3	GS	202	Economics	(3-0)3
MA	211	Mathematics	(3-0)3	MA	212	Mathematics	(3-0)3
PH	201	Physics	(3-2)4	PH	202	Physics	(3-2)4
TE	211	Top Making	(2-6)4	TE	212	Top Making	(2-6)4
WEAV.	211	Weaving for Mfrs.	(2-2)2½	WEAV.	212	Weaving for Mfrs.	(2-2)2½
		Total Credit Hours	20½			Total Credit Hours	20½
*Alternate:				*Alternate:			
GS	461	Pers. Management	(3-0)3	EN	122	Mach. Tool Lab.	(1-2)1
						or	
				GS	226	World Hist. since 1900	(3-0)3

JUNIOR YEAR

CH	221	Intro. to Tex. Chem.	(2-0)2	CH	222	Intro. to Tex. Chem.	(1-3)2
GS	211	Business English	(1-0)1	TE	300	Fabrics	(2-0)2
TE	315	Woolen Yarns	(2-4)3	TE	316	Woolen Yarns	(2-4)3
TE	321	Worsted Yarns	(3-5)5	TE	322	Worsted Yarns	(3-3)4
TE	403	Tex. Evaluation	(2-2)3	TE	404	Tex. Evaluation	(2-2)3
WEAV.	311	Weav. for Mfrs.	(2-2)2½	WEAV.	312	Weav. for Mfrs.	(2-2)2½
**Electives			3 or 4	**Electives			3 or 4
		Total Credit Hours	19½ or 20½			Total Credit Hours	19½ or 20½
**Electives:				**Electives:			
AS	301	Air Science	(4-1)4	AS	302	Air Science	(4-1)4
GS	303	Psychology	(3-0)3	GS	222	Apprec. of Lit.	(3-0)3

SENIOR YEAR

GS	209	Speech	(2-0)2	COT.	432	Cot. Yarn. Mfg. Surv.	(3-1)3
GS	341	Accounting I	(3-0)3	EN	212	Heat and Power	(2-2)3
GS	351	Elem. of Marketing	(2-0)2	EN	422	Ind. Instrumentation	(2-0)2
TE	407	Knitting	(2-3)3	GS	412	Ind. Management	(3-0)3
TE	415	Woolen Mill Organ.	(4-0)4	SYN.	322	Fil. Yarns Surv.	(2-0)1½
TE	423	Wln. and Wstd. Fin.	(2-3)3	TE	424	Wln. and Wstd. Fin.	(2-3)3
**Electives			3 or 4	**Electives			3 or 4
		Total Credit Hours	20 or 21			Total Credit Hours	18½ or 19½
**Electives:				**Electives:			
AS	401	Air Science	(4-1)4	AS	402	Air Science	(4-1)4
GS	301	Eco. Develop. of U.S.	(3-0)3	GS	302	Mod. Labor Problems	(3-0)3

Course III — Textile Design

SOPHOMORE YEAR

First Semester				Second Semester			
*AS	201	Air Science	(2-1)2	*AS	202	Air Science	(2-1)2
DES.	203	Textile Design	(3-2)4	DES.	204	Textile Design	(3-2)4
GS	201	Economics	(3-0)3	GS	202	Economics	(3-0)3
MA	211	Mathematics	(3-0)3	MA	212	Mathematics	(3-0)3
PH	201	Physics	(3-2)4	PH	202	Physics	(3-2)4
TE	217	Color	(1-1)2	TE	218	Color	(1-1)2
WEAV.	201	Weaving	(2-3)3	WEAV.	202	Warp Preparation	(2-3)3
		Total Credit Hours	21			Total Credit Hours	21
*Alternate:				*Alternate:			
GS	209	Speech	(2-0)2	GS	122	Perspective Drawing and	(1-2)2
				GS	212	Business English	(1-0)1

JUNIOR YEAR

CH	221	Intro. to Tex. Chem.	(2-0)2	CH	222	Intro. to Tex. Chem.	(1-3)2
COT.	331	Cot. Yarn Mfr. Surv.	(3-1)3	DES.	302	Textile Design	(2-2)3
DES.	301	Textile Design	(2-2)3	DES.	314	Textile Design	(2-2)3
DES.	313	Textile Design	(2-2)3	TE	300	Fabrics	(2-0)2
GS	341	Accounting—I	(3-0)3	WEAV.	302	Weaving	(2-3)3
WEAV.	301	Weaving	(2-3)3	WOOL	312	Surv. of Wool Mfr.	(3-1)3
**Electives			3 or 4	**Electives			3 or 4
		Total Credit Hours	20 or 21			Total Credit Hours	19 or 20
**Electives:				**Electives:			
AS	301	Air Science	(4-1)4	AS	302	Air Science	(4-1)4
GS	303	Psychology	(3-0)3	Any General Studies subject			(3-0)3

SENIOR YEAR

DES.	403	Textile Design	(2-2)3	DES.	404	Textile Design	(2-2)3
GS	351	Elem. of Marketing	(2-0)2	FIN.	412	Wln. and Wstd. Fin.	(3-3)4
TE	403	Tex. Evaluation	(2-2)3	GS	302	Mod. Labor Problems	(3-0)3
TE	407	Knitting	(2-3)3	SYN.	322	Fil. Yarns Surv.	(2-0)1½
TE	411	Jacquard Design	(1-2)2	TE	404	Tex. Evaluation	(2-2)3
TE	421	Cot. and Syn. Fin.	(3-3)4	TE	422	Adv. Tex. Design	(2-1)2
**Electives			3 or 4	**Electives			3 or 4
		Total Credit Hours	20 or 21			Total Credit Hours	19½ or 20½
**Electives:				**Electives:			
AS	401	Air Science	(4-1)4	AS	402	Air Science	(4-1)4
GS	301	Eco. Develop. of U.S.	(3-0)3	GS	412	Ind. Management	(3-0)3

Course IV — Chemistry and Textile Coloring

SOPHOMORE YEAR

First Semester				Second Semester			
*AS	201	Air Science	(2-1)2	*AS	202	Air Science	(2-1)2
CH	201	Organic Chemistry	(3-3)4	CH	202	Organic Chemistry	(3-3)4
CH	211	Quant. Analysis	(2-6)4	CH	204	Chem. Tech. Fibers	(2-0)2
COT.	231	Cot. Yarn Mfr. Surv.	(2-0)2	CH	212	Quant. Analysis	(2-6)4
MA	203	Math. for Chemists	(4-0)4	MA	204	Math. for Chemists	(4-0)4
PH	201	Physics	(3-2)4	PH	202	Physics	(3-2)4
		Total Credit Hours	20			Total Credit Hours	20
*Alternate:				*Alternate:			
GS	261	Technical German	(3-0)3	GS	262	Technical German	(3-0)3

JUNIOR YEAR

CH	311	Tex. Quant. Anal.	(1-3)2	CH	322	Textile Chemistry	(2-3)3
CH	321	Textile Chemistry	(2-3)3	CH	332	Physical Chemistry	(3-3)4
CH	331	Physical Chemistry	(3-1½)4	CH	364	Tex. Colloid Chem.	(4-0)4
GS	201	Economics	(3-0)3	GS	202	Economics	(3-0)3
TE	101	Elem. Tex. Design	(2-1)2	TE	300	Fabrics	(2-0)2
TE	403	Tex. Evaluation	(2-2)3	TE	404	Tex. Evaluation	(2-2)3
**Electives			4 to 6	**Electives			2 to 4
		Total Credit Hours	21 to 23			Total Credit Hours	21 to 23
**Electives:				**Electives:			
AS	301	Air Science	(4-1)4	AS	302	Air Science	(4-1)4
CH	333	Indust. Stoich.	(3-0)3	CH	312	Tex. Quant. Anal.	(1-3)2
CH	473	Theory of Atomic and Molecular Struc.	(2-0)2	CH	342	Org. Qual. Anal.	(1-3)2
EN	351	Statistical Methods	(3-0)3	CH	352	Chem. Engineering	(3-0)3
***GS	261	Technical German	(3-0)3	GS	262	Technical German	(3-0)3
***GS	361	Technical German	(3-0)3	GS	362	Technical German	(3-0)3

***If elected, German must be continued in second semester.

SENIOR YEAR

CH	411	Adv. Tex. Chem.	(2-9)5	CH	412	Adv. Tex. Chem.	(2-9)5
CH	431	Macro. Chemistry	(2-0)2	CH	422	Adv. Chem. Tex. Test.	(2-3)3
GS	351	Elem. of Marketing	(2-0)2	GS	302	Mod. Labor Problems	(3-0)3
TE	409	Wool and Wstd. Fin.	(3-3)4	TE	408	Cot. and Syn. Fin.	(3-3)4
**Electives			5 or 6	**Electives			4 to 6
		Total Credit Hours	18 or 19			Total Credit Hours	19 to 21

**Subjects, other than Air Science, to be approved by Division Head.

**Subjects, other than Air Science, to be approved by Division Head.

Course V — Synthetic Textiles

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
CH	201	Organic Chemistry	(3-3)4
CH	221	Intro. to Tex. Chem.	(2-0)2
GS	201	Economics	(3-0)3
MA	211	Mathematics	(3-0)3
PH	201	Physics	(3-2)4
TE	101	Elem. Tex. Design	(2-1)2
		Total Credit Hours	20
*Alternate:			
GS	223	The U.S. since 1865	(3-0)3

Second Semester

*AS	202	Air Science	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	222	Intro. to Tex. Chem.	(1-3)2
DES.	222	Fabric Design	(2-1)2
GS	202	Economics	(3-0)3
MA	212	Mathematics	(3-0)3
PH	202	Physics	(3-2)4
		Total Credit Hours	20
*Alternate:			
GS	222	Apprec. of Lit.	(3-0)3
GS	226	World Hist. since 1900	(3-0)3

JUNIOR YEAR

First Semester

DES.	303	Syn. Fab. Des.	(1-2)2
SYN.	301	Fil. Yarn. Proc.	(2-0)2
SYN.	311	Mfr. of Syn. Fibers	(3-0)3
TE	403	Tex. Evaluation	(2-2)3
WEAV.	211	Weav. for Mfrs.	(2-2)2½
WOOL	311	Surv. of Wool Mfr.	(3-1)3
**Electives			3 or 4
		Total Credit Hours	18½ or 19½
**Electives:			
AS	301	Air Science	(4-1)4
GS	301	Eco. Develop. of U.S.	(3-0)3

Second Semester

COT.	332	Cot. Yarn Mfr. Surv.	(3-1)3
SYN.	332	Fil. Yarn Lab.	(0-3)1
TE	300	Fabrics	(2-0)2
TE	312	Structure and Prop. of Syn. Fibers	(3-0)3
TE	320	Throwing Plant Org.	(2-0)2
TE	404	Tex. Evaluation	(2-2)3
WEAV.	212	Weav. for Mfrs.	(2-2)2½
**Electives			3 or 4
		Total Credit Hours	19½ or 20½
**Electives:			
AS	302	Air Science	(4-1)4
GS	302	Mod. Labor Problems	(3-0)3

SENIOR YEAR

First Semester

EN	431	Adv. Phys. Testing	(1-3)2
GS	351	Elem. of Marketing	(2-0)2
TE	407	Knitting	(2-3)3
TE	421	Cot. and Syn. Fin.	(3-3)4
TE	427	Prop. and Appl. of Syn. Fibers	(3-0)3
WEAV.	311	Weav. for Mfrs.	(2-2)2½
**Electives			3 or 4
		Total Credit Hours	19½ or 20½
**Electives:			
AS	401	Air Science	(4-1)4
GS	303	Psychology	(3-0)3
GS	461	Pers. Management	(3-0)3

Second Semester

GS	210	Speech	(2-0)2
GS	314	Phil. of Science	(3-0)3
GS	412	Ind. Management	(3-0)3
SYN.	452	Syn. Tex. Seminar	(2-0)2
TE	428	Prop. and Appl. of Syn. Fibers	(3-0)3
WEAV.	312	Weaving for Mfrs.	(2-2)2½
**Electives			3 or 4
		Total Credit Hours	18½ or 19½
**Electives:			
AS	402	Air Science	(4-1)4
GS	344	Prin. of Selling	(3-0)3
GS	466	Management Problems	(3-0)3
PH	402	Textile Physics	(2-3)3

Course VI-G — General Manufacturing Option

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
GS	201	Economics	(3-0)3
MA	201	Anal. Geom. and Calc.	(4-0)4
PH	201	Physics	(3-2)4
TE	101	Elem. Tex. Des.	(2-1)2
TE	213	Cotton Carding	(3-2)4
WOOL	215	Top Making	(2-2)3
		Total Credit Hours	22
*Alternate:			
WEAV.	221	Weav. for Engrs.	(2-0)2

Second Semester

*AS	202	Air Science	(2-1)2
DES.	224	Fabric Design	(2-1)2
DES.	234	Fabric Design	(2-1)2
MA	202	Anal. Geom. and Calc.	(4-0)4
PH	202	Physics	(3-2)4
TE	214	Cotton Carding	(3-2)4
WOOL	216	Top Making	(2 2)3
		Total Credit Hours	21
*Alternate:			
WEAV.	222	Weav. for Engrs.	(2-0)2

JUNIOR YEAR

First Semester

CH	221	Int. to Tex. Chem.	(2-0)2
COT.	303	Cotton Spinning	(2-2)3
EN	321	Strength of Mat.	(3-0)3
PH	321	Electronics	(3-1)3
TE	403	Tex. Evaluation	(2-2)3
WEAV.	333	Weav. for Engrs.	(1-2)1½
*WOOL	323	Woolen Yarns	(2-2)2½
*WOOL	325	Worsted Yarns	(3-2)3½
		Total Credit Hours	21½
*Alternate for either WOOL 323 or 325:			
AS	301	Air Science	(4-1)4

Second Semester

CH	222	Int. to Tex. Chem.	(1-3)2
COT.	304	Cotton Spinning	(2-2)3
EN	344	Electrical Machinery	(3-2)4
TE	300	Fabrics	(2-0)2
TE	404	Tex. Evaluation	(2-2)3
WEAV.	334	Weav. for Engrs.	(1-2)1½
*WOOL	324	Woolen Yarns	(2-2)2½
*WOOL	326	Worsted Yarns	(3-2)3½
		Total Credit Hours	21½
*Alternate for either WOOL 324 or 326:			
AS	302	Air Science	(4-1)4

SENIOR YEAR

First Semester

EN	403	Prin. of Heat Eng.	(3-2)4
EN	431	Adv. Phys. Test.	
		or	(1-3)2
PH	401	Tex. Microscopy	
GS	341	Accounting I	(3-0)3
TE	417	Mill Org.	(4-0)4
TE	421	Cot. and Syn. Fin.	(3-3)4
**Electives			3 or 4
		Total Credit Hours	20 or 21
**Electives:			
AS	401	Air Science	(4-1)4
GS	301	Econ. Devel. of U.S.	(3-0)3

Second Semester

EN	402	Tex. Appl. of Elec.	(1-4)1
EN	422	Ind. Instrumentation	(2-0)2
FIN.	412	Wln. and Wstd. Fin.	(3-3)4
GS	212	Business English	(1-0)1
GS	412	Ind. Management	(3-0)3
KNIT.	404	Knitting	(2 3)3
SYN.	322	Fil. Yarns Sur.	(2-0)1½
**Electives			4 or 5
		Total Credit Hours	19½ or 20½
**Electives:			
AS	402	Air Science	(4-1)4
GS	210	Speech	(2-0)2
GS	302	Mod. Labor Prob.	(3-0)3

Course VII — Textile Sales and Management

SOPHOMORE YEAR

First Semester				Second Semester			
*AS	201	Air Science	(2-1)2	*AS	202	Air Science	(2-1)2
DES.	223	Fabric Design	(2-1)2	DES.	222	Fabric Design	(2-1)2
GS	201	Economics	(3-0)3	GS	202	Economics	(3-0)3
MATH	211	Mathematics	(3-0)3	GS	206	Man and His Envir.	(3-0)3
PH	201	Physics	(3-2)4	MATH	212	Mathematics	(3-0)3
TE	217	Color	(1-1)2	PH	202	Physics	(3-2)4
WEAV.	333	Weav. for Engrs.	(1-2)1½	TE	218	Color	(1-1)2
WOOL	311	Surv. of Wool Mfr.	(3-1)3	WEAV.	334	Weav. for Engrs.	(1-2)1½
		Total Credit Hours	20½			Total Credit Hours	20½

*Alternate: Elective approved by Division Head | *Alternate: Elective approved by Division Head

JUNIOR YEAR

CHEM.	221	Intro. to Tex. Chem.	(2-0)2	CHEM.	222	Intro. to Tex. Chem.	(1-3)2
COT.	331	Cot. Yarn Mfg. Surv.	(3-1)3	DES.	232	Fabric Design	(2-1)2
DES.	233	Fabric Design	(2-1)2	GS	314	Phil. of Science	(3-0)3
GS	311	Eco. Statistics	(3-0)3	GS	322	Mark. Princ. and Prac.	(3-0)3
GS	321	Mark. Princ. and Prac.	(3-0)3	GS	344	Prin. of Selling and Adv.	(3-0)3
TE	403	Tex. Evaluation	(2-2)3	TE	404	Tex. Evaluation	(2-2)3
**Electives			3 or 4	**Electives			3 or 4
		Total Credit Hours	19 or 20			Total Credit Hours	19 or 20

**Electives: AS 301 Air Science (4-1)4; Elective approved by Division Head | **Electives: AS 302 Air Science (4-1)4; Elective approved by Division Head

SENIOR YEAR (Except for Class of 1955)

GS	301	Eco. Develop. of U.S.	(3-0)3	FIN.	412	Wln. and Wstd. Fin.	(3-3)4
GS	303	Psychology	(3-0)3	GS	302	Mod. Lab. Prob.	(3-0)3
GS	341	Accounting I	(3-0)3	GS	342	Accounting II	(3-0)3
GS	463	Business Law	(3-0)3	GS	412	Industrial Man.	(3-0)3
TE	421	Cot. and Syn. Fin.	(3-3)4	SYN.	322	Fil. Yarns Surv.	(2-0)1½
**Electives			3 or 4	**Electives			3 or 4
		Total Credit Hours	19 or 20			Total Credit Hours	17½ or 18½

**Electives: AS 401 Air Science (4-1)4; Elective approved by Division Head | **Electives: AS 402 Air Science (4-1)4; Elective approved by Division Head

SENIOR YEAR (Class of 1955 only)

DES.	233	Fabric Design	(2-1)2	FIN.	412	Wln. and Wstd. Fin.	(3-3)4
GS	301	Eco. Develop. of U.S.	(3-0)3	GS	302	Mod. Lab. Prob.	(3-0)3
GS	341	Accounting I	(3-0)3	GS	342	Accounting II	(3-0)3
GS	463	Business Law	(3-0)3	GS	412	Industrial Man.	(3-0)3
TE	421	Cot. and Syn. Fin.	(3-3)4	SYN.	322	Fil. Yarns Surv.	(2-0)1½
**Electives			3 or 4	**Electives			3 or 4
		Total Credit Hours	18 or 19			Total Credit Hours	17½ or 18½

**Electives: AS 401 Air Science (4-1)4; Elective approved by Division Head | **Electives: AS 402 Air Science (4-1)4; Elective approved by Division Head

SUBJECT DESCRIPTIONS

CHEM. 221 Introduction to Textile Chemistry (2-0)2

[CH 102]

Not open to students in Course IV

This subject is designed for the non-chemist and consists of a series of lectures covering the various processes preliminary to dyeing. The preliminary treatments given the natural and manufactured fibers are covered as well as the action and properties of the textile chemicals used in these processes.

CHEM. 222 Introduction to Textile Chemistry (1-3)2

[CHEM. 221]

Not open to students in Course IV

A continuation of CHEM. 221. The application of the various classes of dyes to the natural and manufactured fibers is covered. The methods of dyeing, the fastness properties of the different classes of dyes, and the nature and use of dyeing assistants are taken up. The principles covered in the lectures are illustrated by work in the laboratory.

CHEM. 431 Macromolecular Chemistry of Textile Processes (2-0)2

[CH 332 and 362]

The principles of general colloid chemistry applied to specific textile applications. Wetting, detergency, the fibers themselves, dyes, and finishing processes are studied from the colloidal aspect.

COTTON 303-304 Cotton Spinning (2-2)(2-2)6

[TE 214, formerly COTTON 202]

Similar to TE 313–314, but with less laboratory practice.

COTTON 331 or 332 Cotton Yarn Manufacture Survey (3-1)3

Not open to students in Course I or VI-G

For students with but a secondary interest in cotton manufacture, this survey outlines the processes used and the principles of cotton yarn manufacture. The work considers cotton qualities and production, the processes of opening, picking, carding, combing, drawing, roving, spinning, winding, and twisting.

COTTON 411-412 **Major Project** **Credit to be arranged**

[TE 314, formerly COTTON 302, and
TE 318, formerly COTTON 322]

This subject offers qualified students an opportunity to work in some phase of cotton manufacturing in which they may be particularly interested. Topics must be approved by the head of the department.

COTTON 432 **Cotton Yarn Manufacture Survey** **(3-1)3**

Not open to Course I or VI-G

Similar to COTTON 332, but arranged particularly for those with a background in wool, drawing parallels whenever possible between woolen and cotton systems.

DES. 103 or 104 **Yarn Calculation** **(1-0)1**

Relations and determinations of yarn numbers of cotton, woolen, worsted, linen, silk, and synthetic; grading of folded, ply, novelty and fancy yarns.

DES. 203-204 **Textile Design and Fabric Analysis** **(3-2)(3-2)8**

[TE 102, formerly DES. 102, and DES. 104]

Open only to students in Course III

In the first semester, consideration is given to cotton and synthetic fabrics, both filament and spun, weaving plain, twill, or sateen constructions, and employing stripe, check or plaid patterns. In the second semester, fabrics studied are those having extra warp and extra filling figured patterns, Bedford cords, velveteens, plushes and corduroy, as well as 2-ply, 3-ply, and 4-ply fabrics, together with their analysis in wide woven widths. In both semesters, the work includes the analysis of the fabrics as well as the necessary calculations required to reproduce them or to construct fabrics of similar character.

DES. 222-223 **Fabric Design and Analysis for Manufacturers** **(2-1)(2-1)4**

[TE 101, formerly DES. 101, and DES. 103]

Not open to students in Course III

Similar to, but less detailed than, DES. 203–204 and DES. 301–302.

DES. 224 **Fabric Design and Analysis for Engineers** **(2-1)2**

[TE 101, formerly DES. 101, and DES. 103]

Not open to students in Course III

This is a skeleton subject patterned after DES. 222–223.

DES. 232-233 **Fabric Design and Analysis for Manufacturers** **(2-1)(2-1)4**

[TE 101, formerly DES. 101, and DES. 103]

Not open to students in Course III

Similar to, but less detailed than, DES. 313–314 and DES. 403–404.

DES. 234 **Fabric Design and Analysis for Engineers** **(2-1)2**

[TE 101, formerly DES. 101, and DES. 103]

Not open to students in Course III

This is a skeleton subject patterned after DES. 232–233.

DES. 261 **Color** **(1-1)1**

A short version of TE 217–218.

DES. 271 or 272 **Color** **(1-1)1**

This subject includes the same general information as DES. 261 but deals with blends of colored stock.

DES. 301-302 **Textile Design and Fabric Analysis** **(2-2)(2-2)6**

[DES. 204]

Open only to students in Course III

In the first semester, consideration is given to cotton ply fabrics including the weave and construction of two-ply, three-ply, and four-ply fabrics together with the analysis of these fabrics in narrow woven nonelastic and elastic belts and webs. The second semester covers piques, lappet and swivel-woven fabrics, as well as Mitchelins, loose and fast-back quilting fabrics, toilet cloths, and leno fabric design using the modern steel doups and super-doups.

DES. 303 **Synthetic Fabric Design and Analysis** **(1-2)2**

[DES. 222 or 224]

The comparison and analysis of various synthetic fabrics as to the construction, yarn denier, filament size, and weave, as well as finished fabric characteristics.

DES. 313-314 **Textile Design and Fabric Analysis** **(2-2)(2-2)6**

[TE 102, formerly DES. 102, and DES. 104]

Open only to students in Course III

In the first semester, instruction is given in the construction and analysis of standard woolen and worsted fabrics containing synthetic yarn or mixes. In the second semester, instruction is given in the construction of warp and filling backs, double and triple cloths. Chinchillas, and extra warp and filling figures.

DES. 403-404 Textile Design and Fabric Analysis (2-2)(2-2)6

[DES. 314]

Open only to students in Course III

This subject includes cost estimating for worsted and woolen fabrics and the cost of various blends and mixes of stock and loom production. The work in cloth construction includes the application of the different weaves and their combinations in the production of fancy designs as well as the calculation involved in the reproduction of various fabrics changed to meet varying conditions of weight, stock, size of yarn and value. Particular attention is given to the construction of new designs by the use of suggestion sheets as well as to the new fabrics to be constructed upon a base fabric, previously analyzed, in the manner outlined on the suggestion sheets, keeping within the given price range. This includes Designer's Blankets to be worked out as required by the suggestion sheets. This subject is restricted to woolen and worsted fabrics, but includes blends with other fibers, as well as filament yarn combinations for fancy effects.

DES. 421 or 422 Design and Weaving Seminar Credits and hours to be arranged

[Major in Course III or by special permission]

This subject consists of field trips to selected mills, alternating with reports and seminar discussion of field work.

ENG. 212 Heat and Power (2-2)3

[PH 201]

Not open to students in VI-E or VI-G

Similar to EN 403, but briefer and designed for those not majoring in engineering.

FIN. 412 Woolen and Worsted Finishing (3-3)4

[CH 102 or 104]

Not open to students in Course II

An abbreviated version of TE 423–424.

FIN. 422 Cotton and Synthetic Finishing (0-3)1

[TE 421, formerly FIN. 421]

A continuation of TE 421 with emphasis on conversions of blends, knit goods and printed fabrics.

KNIT. 404 Knitting (2-3)3

[EN 203, formerly ENG. 102, and EN 112]

Similar to TE 419, but with less laboratory work.

MATH. 203 **Mathematics for Chemists** **(4-0)4**

[MA 102, formerly MATH. 104]

A continuation of MA 102. Analytic geometry and calculus including the following topics: maximum and minimum values, rates and differentials, the conic sections, indefinite integrals, summation by integration, areas, volumes, pressures.

MATH. 211-212 **Mathematics** **(3-0)(3-0)6**

[MA 102, formerly MATH. 104]

The first semester's work considers applications of differentiation, analytic geometry of the conic sections, and integration of algebraic functions. Topics of the second semester include: applications of integration, construction of nomographic charts, and the derivation of empirical equations.

SYN. 301 **Filament Yarn Processing** **(2-0)2**

The processing of natural and man-made continuous filament fibers from the time they are made available to the textile industry by the manufacturer until they are ready for processing in fabric forms. The nomenclature, purposes, means of accomplishment, and results obtained in the various operations of soaking, winding, throwing, twist setting, coning, and single end sizing.

SYN. 311 **Manufacture of Synthetic Fibers** **(3-0)3**

[CH 202]

The rayon, estron, polyamide, polyester, vinyl, protein, mineral and metallic fibers, considered from the standpoint of their manufacturing and economic aspects. The types of processes and the chemistry (reactions and structures) involved in the manipulation of natural high polymers and the synthesis and manipulation of synthetic high polymers into useful textile fibers.

SYN. 322 **Filament Yarns Survey** **(2-0)1½**

Not open to students in Course V

This survey is divided into two phases, one pertaining to a brief review of the essential methods involved in the manufacture of man-made fibers, including also their basic physical and chemical properties, and the other pertaining to the handling of natural and synthetic fibers in filament form by a throwster for subsequent utilization by a weaving or knitting plant. Some of the lecture time is devoted to laboratory demonstration.

SYN. 332 **Filament Yarn Laboratory** **(0-3)1**

[SYN. 301]

The laboratory aspects of SYN. 301, consisting of planned experiments and demonstrations involving the study of throwing machinery

and processes by the student. Experiments include yarn soaking, winding, twisting, coning, and single end sizing operations, and the related machine design and function aspects.

SYN. 452 Synthetic Textiles Seminar (2-0)2

[TE 320, formerly SYN. 302, and TE 411, formerly SYN. 411]

A general discussion of the problems encountered in the synthetic textile field, including economics, manufacture, processing, properties and various aspects of research. Recent advances and projected developments will be covered. Participation by both students and instructors in the seminar develops an objective viewpoint of the subject by the student.

WEAV. 201 Weaving (2-3)3

A study of cam looms, their principal and auxiliary motions, including the Warner Swasey Sulzer weaving machine, a comparison with other types of looms, and a study of weaving terms and cloth defects in the weaving process. Narrow fabric weaving is incorporated in the laboratory exercises.

WEAV. 202 Warp Preparation (2-3)3

All methods of warp preparation of all yarns with emphasis upon the conditions favorable to each or combinations of systems.

WEAV. 211 Weaving for Manufacturers (2-2)2½

Similar to WEAV. 201, but requiring less laboratory time.

WEAV. 212 Warp Preparation for Manufacturers (2-2)2½

Similar to WEAV. 202, but with less laboratory work.

WEAV. 221 Weaving for Engineers (2-0)2

Similar to WEAV. 201, but without laboratory work.

WEAV. 222 Warp Preparation for Engineers (2-0)2

Similar to WEAV. 202, but without laboratory work.

WEAV. 301-302 Weaving (2-3)(2-3)6

[WEAV. 201]

This subject covers dobby weaving and includes single and double index, single and double cylinder, chains, timing, and adjusting. Jacquard instruction covers single lift, double lift and double cylinder jacquards, and includes harness tie-ups, card cutting, timing, and adjusting. The instruction on the Crompton & Knowles looms includes 4 x 4 woolen and worsted, automatics and silk. This subject also covers pile cloth weaving, carpet weaving, and leno weaving.

WEAV. 311-312 **Weaving for Manufacturers** **(2-2)(2-2)5**
[WEAV. 201 or 211]

Similar to WEAV. 301–302, but with less laboratory time.

WEAV. 321-322 **Weaving for Engineers** **(2-0)(2-0)4**
[WEAV. 201 or 211 or 221]

Similar to WEAV. 301–302, but without laboratory work.

WEAV. 333-334 **Weaving for Engineers** **(1-2)(1-2)3**
[DES. 223, 233 or DES. 224, 234]

Warp preparation and weaving, with emphasis on basic principles. The different systems of warp preparation are described and compared. Each type of loom is described, and the capabilities and limitations of each are discussed. Considerable time is devoted to fabric defects, their cause and correction.

WOOL 215-216 **Top Making** **(2-2)(2-2)6**
[EN 102 and 112]
Not open to students in Course II

Similar to TE 211–212, but with reduced laboratory work.

WOOL 311 or 312 **Survey of Wool Manufacture** **(3-1)3**
Not open to students in Course II or VI-G

A comprehensive survey of woolen and worsted yarn, reprocessed and reused fiber, and felt manufacturing processes as they relate to the manipulation of all types of fiber, but with primary emphasis on wool.

WOOL 323-324 **Woolen Yarns** **(2-2)(2-2)5**
[TE 212, formerly WOOL 212, or WOOL 216]
Not open to students in Course II

Similar to TE 315–316, but with less laboratory work.

WOOL 325-326 **Worsted Yarns** **(3-2)(3-2)7**
[WOOL 216]
Not given to students in Course II

Similar to TE 321–322, but with reduced laboratory time.

HONORARY DEGREE RECIPIENTS

MASTER OF SCIENCE

COMMENCEMENT 1950

Honorable Paul Andrew Dever
Samuel Pinanski
Edward Robinson Schwarz
Abbot Stevens
George Herbert Varney

COMMENCEMENT 1951

John Henry Dillon
Herman Feldman
Kenneth Russell Fox
Ralph King Hubbard
Francis Wilford White

SPECIAL CONVOCATION—December 1951

Edward Thomas Pickard
Harold Watson Leitch
Walter Julian Hamburger
George Tucker Metcalf
Charles Sawyer

COMMENCEMENT 1952

William Dunford Appel
General Georges Frederic Doriot
Francis Patrick Madden
Harry Riemer
Laurence Frederick Whittemore

COMMENCEMENT 1953

Frederick Morris Feiker
Jewett Taylor Flagg
Julian Slack Jacobs
Gordon Osborne
Honorable Edith Nourse Rogers
Joseph Hollis Sutherland

DEGREES CONFERRED IN 1953

BACHELOR OF SCIENCE

Robert Godfrey Adell
Robert Francis Albani
Edgar Baerwald Arendt
Herbert Barber
James Joseph Barrett
George Lytton Baxter, Jr.
Richard Allen Beals
Abner Meyer Beder
Peter Bedrosian
Stanley Berger
I. Milton Berkowitz
Robert Albert Binns
Sanford Brandt
John Neil Carroll
William David Carty
William Morgan Copley
Robert James Cross
Lawrence Benjamin Danza
Charles George Darsch, Jr.
John Bernard David, Jr.
William Joseph DeFusco
Harry John Demas
Michael Dielendick
Donald David Dooley
Abe Wilder Essig
Muwaffaq Nouri Fattah
Donald Erwin Finegold
Harvey Martin Fishman
Norman James Fox
Eugene F. Froehlich
Leonard Goodman
George Joseph Gosselin, Jr.
Richard Francis Goulart
Leonard Grubman
Lawrence Anthony Glynn Haley
Richard King Hall
Gerald Roland Hamel
Paul David Harris
Everett Alvah Hilliard, Jr.
Ralph Edward Hudson, Jr.
Kenneth Kamerman
Robert Ralph Kelleher
Roger John Langlais
George Campbell Lawrence
Neil MacLellan, Jr.
Jerome Irwin Madans
Alfred Joseph Magnant, Jr.
Warren Paul McHugh
Francis Michael McKniff
Steven G. Nachman
James Anthony Nelligan
Franklin Ashworth Nordon
William Arthur Norman
Donald Martin Ostrove
Irin Myron Paris
Stephen A. Peltekian
Walter Frank Polak
Robert Michael Profio
Thomas Henry Randall, Jr.
Maurice W. Richardson, Jr.
Robert Versal Robey
Bertram Robert Robinson, Jr.
Manuel M. Rocha
Ira Morvay Rottenberg
Morton Ira Saks
Roger James Sanborn
Jerry Laurence Schain
Stanley Charles Scheier
Murray Mark Shantzis
Donald Siegal
William Richard Smith
Harold Murray Stein
David Charles Stone
Morris Harvey Swanson
William Henry Uster
James Anastas Velantzas
John Vincent Walsh, Jr.
Melvin Wiener
Erwin August Wuester

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*James Paul Boutiette
*Arnold Allan Brody
*John Lawrence Devereaux
*Charles David Flamand
*Joseph Patrick Flannery
*Richard Jewett Kelley
*Kandaswamy V. Ramachandran
*Alfred Joseph Richard
*Earl Sidelinker
*Charles Goward Tewksbury
*Itzhak Zagiel

BACHELOR OF SCIENCE WITH HIGH HONORS

*David Hillel Abrahams
*Robert Morris Greenberg
*John Francis Kaslow
*Robert Edward Mulcahy

BACHELOR OF SCIENCE WITH HIGHEST HONORS

*Carl Frederick Pihl

MASTER OF SCIENCE

David Leon Aelion
Textile Engineering
B.S., Lowell Textile Institute, 1952

Gerald Francis Barry
Textile Chemistry
B.S., Lowell Textile Institute, 1952

Umakant Bhattacharya
Textile Engineering
L.T.M., Victoria Jubilee Technical Institute, 1944

Benjamin Bautista Bilbao
Textile Chemistry
B.S., Atlantic University, 1949

*Milton Boches
Textile Chemistry
B.S., Lowell Textile Institute, 1952

*Tau Epsilon Sigma (*Textile Scholastic Society*)

Donald Pearson Feyler
Textile Chemistry
B.S., Lowell Textile Institute, 1950

Trevor Alexander Finnie
Textile Chemistry
B.S., Sir George Williams College, 1951

*Michael Joseph Koroskys
Textile Manufacturing
B.S., Lowell Textile Institute, 1952

*Florence Patricia Liston
Textile Chemistry
B.S., Lowell Textile Institute, 1952

Andrew Tze-Chiu Liu
Textile Chemistry
B.S., Indiana University, 1951

Edwin Lincoln Lord, Jr.
Textile Engineering
B.S., Lowell Textile Institute, 1950

*Robert Albert Olney
Textile Chemistry
B.S., Lowell Textile Institute, 1952

Felix Luis Ortiz
Textile Engineering
B.S.M.E., University of Puerto Rico, 1948

Robert John Peirent
Textile Chemistry
B.S., Lowell Textile Institute, 1949

R. Safioen
Textile Chemistry
B.S., Sri Krishnarajendra Silver Jubilee Technological Institute, 1951

S. R. Anantha Krishna Setty
Textile Chemistry
B.S., Sri Krishnarajendra Silver Jubilee Technological Institute, 1950

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*Tau Epsilon Sigma (*Textile Scholastic Society*)

SERIES 58. NO: 1. August, 1954

BULLETIN

OF THE

Lowell Technological Institute

LOWELL, MASS.

1954-1955

Entered August 26, 1902, at Lowell, Mass., as second-class matter
under Act of Congress of July 16, 1894

Textile and Colonial Avenue

EVENING DIVISION CATALOGUE

PUBLICATION OF THIS DOCUMENT APPROVED BY GEORGE J. CRONIN, STATE PURCHASING AGENT
LTI-6-5M-7-54-912767

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CALENDAR — 1954–1955

'irst Semester

eptember 13, 14, 21, 1954, 7–8:30 P.M. . . .	Registration
eptember 27, 1954, Monday	Classes begin
'ctober 12, 1954, Tuesday	Columbus Day, Holiday
'ovember 11, 1954, Thursday	Armistice Day, Holiday
'ovember 24, 25, 1954, Wednesday and Thursday	Thanksgiving Recess
'ecember 20, 1954, Monday	Christmas Recess begins
anuary 3, 1955, Monday	Classes resume
anuary 20, 1955, Thursday	End of First Semester

econd Semester

anuary 18, 19, 20, 1955, 7–8:30 P.M. . . .	Registration
anuary 31, 1955	Classes begin
ebruary 22, 1955, Tuesday	Washington's Birthday, Holiday
pril 4, 1955, Monday	Easter Recess begins
pril 11, 1955, Monday	Classes resume
pril 19, 1955, Tuesday	Patriots' Day, Holiday
'ay 19, 1955, Thursday	End of Second Semester

GENERAL INFORMATION

Entrance Requirements

Entrance requirements vary with the subject selected. For subjects taken toward a certificate, the requirement, in general, is graduation from grammar school or presentation of equivalent education. For subjects taken for college credit, the requirement is graduation from a recognized high school or presentation of equivalent study or achievement.

Evidence of equivalent education, in place of grammar or high school graduation, may be given by taking an examination, usually on registration evenings, or by presenting records of various courses taken elsewhere.

Registration

Students must register by filling out the necessary forms and paying fees before attending classes. Registration is held on the dates indicated in the calendar above or on the opening nights of the various classes. Much time will be saved by registering on the evenings set aside for that purpose.

Sessions

Classes are held on Monday, Tuesday, Wednesday and Thursday evenings each week, usually from 7 to 9 P.M., although other hours are sometimes required in particular subjects. The subjects offered require from one evening per week to three evenings per week. (See subject schedules.)

The scheduled nights for the various subjects in the following pages are tentative and may be altered in a few cases.

Fees and Deposits

A registration fee of one dollar per semester is required of *all* students, in addition to tuition and other charges.

Tuition for subjects not offering college credit is free to residents of Lowell, but non-residents will be charged as follows per semester:

Subjects meeting one evening per week	$5
Subjects meeting two evenings per week	$10
Subjects meeting three evenings per week	$15

To receive free tuition, residents of Lowell must file a certificate of residence with the Registrar. These certificates may be obtained from the Election Commission, City Hall, Lowell. However, registration may be completed prior to filing this certificate.

All students taking subjects for college credit will be charged $9 per credit to a maximum of $25. However, college-level subjects may be taken without college credit at the rate charged for non-credit courses.

Students electing any chemistry course that requires laboratory work must pay a laboratory fee of $10 per semester in addition to their tuition. Those electing Machine Shop Practice must pay a laboratory fee of $5 per semester in addition to tuition. These fees are to cover supplies and normal breakage. Any excessive breakage will be billed directly to the student and must be paid before credit can be obtained for the course. No portion of these laboratory fees will be returned except as provided in the section on refunds. These laboratory fee requirements apply to *all* students registering in these courses whether they are residents or non-residents of Lowell.

Regularly enrolled day school students at the Lowell Technological Institute may take evening courses, except for college credit, without charge for tuition but must pay the one dollar registration fee and the laboratory fee where the latter is required.

All fees must be paid in full at the time of registration.

[R]EFUNDS

Students dropping out of a course any time before the end of the first five weeks [o]f the semester may obtain a refund of one-half their tuition and one-half of any [la]boratory fee paid, *provided application for such refund is made prior to the ex[p]iration of the first five weeks.* No refunds of any kind will be made after the first [fi]ve weeks. The registration fee of one dollar will not be returned in any case unless [th]e course is cancelled.

[L]ATE REGISTRATION

No new registrations or course changes will be accepted for any course after the [fi]rst three weeks of classes have been held in that course.

[V]ETERANS

All L.T.I. Evening Division courses are approved for study under the G.I. Bill [of] Rights. World War II Veterans currently in training who have remaining educa[ti]onal entitlement may complete their program subject to VA regulations. Korean [V]eterans should make application for educational benefits at their Veterans Admin[is]tration Office and secure a certificate of eligibility before registering. However, [K]orean Veterans will be required to pay the full tuition and registration fee at the [ti]me of registration.

[B]OOKS AND SUPPLIES

Students must provide their own books, paper, drawing materials, etc., and pay [fo]r any breakage or damage of school equipment that they may cause.

Student supplies will be sold by the school cooperative store each evening school [n]ight from 6:45 to 8:15 P.M.

[S]IZE OF CLASSES

No first year course will be given unless at least 10 men register for it and, in a [fe]w instances, more than that number. Advanced courses will usually, but not [n]ecessarily, be given, regardless of number.

[I]NCLEMENT WEATHER

Due to difficulties in notifying in time students and instructors who reside at a [d]istance, evening school will not be cancelled for reasons of weather at any time.

[A]TTENDANCE

Students must attend 70% of all classes held in a course in order to receive [c]redit for the course. Four unexplained absences in a row will result in the student [b]eing automatically dropped from the rolls.

[C]REDITS

Subjects considered of college level are indicated in the subject descriptions and [c]redit hours are assigned to them. A high-school diploma is a prerequisite for all [co]llege-level courses.

[D]IPLOMAS

Diplomas will not be offered to new students. However, students who indicate [th]at they are already working toward a diploma under previous provisions will be [a]llowed to continue their course and, if they successfully complete the requirements [t]hereof prior to June, 1958, will be granted their diploma. Such students should in[fo]rm the Registrar of their intentions at the time of registration.

Certificates

Certificates will be awarded for the satisfactory completion of each semester subject except that in the following courses a certificate can be earned only by passing all subjects listed after each course.

Architectural Drawing E-13A, B, E, and F

College Chemistry C-33 and C-34

College Quantitative Analysis C-36 and C-37

Cotton Design M-27, M-28, and M-51

Cotton Yarns M-11, M-12, M-13, and M-14

Electrical Circuits E-44 and E-45

General Chemistry C-31 and C-32

Machine Shop Practice E-14 and E-15

Mechanical Drawing E-13A, B, C, and D

Physical Chemistry C-21 and C-22

Practical Leather Chemistry E-60 and E-61

Pulp and Paper Technology E-1 and E-2

Textile Chemistry and Dyeing C-23, C-24, C-25, and C-26

Woolen and Worsted Design M-29, M-30, and M-51

CHEMISTRY

Prof. George R. Griffin, B.S., M.A., Ph.D., *Chairman of Division*
Assoc. Prof. William G. Chace, Ph.B., M.S.
Assoc. Prof. Ernest P. James, B.T.C., M.S.
Assoc. Prof. Allen Scattergood, A.B., Ph.D.
Asst. Prof. Charles L. Daley, B.T.C.
Asst. Prof. Charles A. Everett, B.T.C.
Asst. Prof. Charles L. Howarth, B.T.C.
Asst. Prof. Walter J. Lisien, B.T.C.
Mr. Herman Brown, B.S., M.S., Instructor, L.T.I.
Mr. Vasilis Lavrakas, B.S., M.S., Instructor, L.T.I.
Mr. Ray E. MacAusland, Instructor, L.T.I.
Mr. Robert J. Peirent, B.S., M.S., Instructor, L.T.I.

First Semester Subjects (Sept.-Jan.)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
College Chemistry	C-33	Mon., Tues. & Thurs.	C-32
College Quantitative Analysis	C-36	Mon., Tues. & Thurs.	C-35
General Chemistry	C-31	Mon., Tues. & Thurs.	None
Organic Chemistry	C-38	Mon. & Thurs.	C-34
Physical Chemistry	C-21	Tues. & Thurs.	C-37
Qualitative Analysis	C-35	Mon., Tues. & Thurs.	C-34
Quantitative Analysis	C-41	Mon., Tues. & Thurs.	C-35
Textile Chemistry & Dyeing	C-23	Mon., Tues. & Thurs.	C-39
Textile Chemistry & Dyeing	C-25	Mon., Tues. & Thurs.	C-24

Second Semester Subjects (Jan.-May)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
College Chemistry	C-34	Mon., Tues. & Thurs.	C-33
College Quantitative Analysis	C-37	Mon., Tues. & Thurs.	C-36
General Chemistry	C-32	Mon., Tues. & Thurs.	C-31
Physical Chemistry	C-22	Tues. & Thurs.	C-21
Technology of Fibers	C-39	Tues. & Thurs.	C-38
Textile Chemistry & Dyeing	C-24	Mon., Tues. & Thurs.	C-23
Textile Chemistry & Dyeing	C-26	Mon., Tues. & Thurs.	C-25
Textile Quantitative Analysis	C-42	Mon., Tues. & Thurs.	C-41

Subject Descriptions

C-21 and C-22 Physical Chemistry. This subject is designed for those in the laboratory or industry. It includes a discussion of properties of gases, liquids, solids, and solutions; chemical equilibrium, phase equilibrium, thermochemistry, electrochemistry, and other topics according to the need of the students. Laboratory work is assigned as required to give the student practice in the methods and apparatus of Physical Chemistry. Laboratory work includes the measurement of vapor pressure, viscosity, surface tension, heat of combustion and reaction, conductivity, determination of molecular weight, pH by various methods, etc. The first semester is largely lectures and the second is mostly laboratory. College credit (except for chemistry majors): C-21 — 4 credit hours; C-22 — 1 credit hour.

C-23, C-24, C-25, C-26 Textile Chemistry and Dyeing, The action of chemical reagents on the natural and synthetic fibers; the preparation of fibers for dyeing; the application of all classes of dyes to cotton, wool, silk, synthetic and union materials; and the testing techniques involved in measuring fastness to light, washing, crocking, perspiration, etc. One lecture, 7–9 P.M., and two laboratories, 7–9 P.M., per week.

C-31 and C-32 General Chemistry. Two semesters of basic Inorganic Chemistry for those with no previous knowledge of Chemistry. The fundamental laws of Chemistry; the preparation, properties and uses of metals, non-metals and related compounds; and simple chemical calculations. Two lectures, 7–9 P.M., and one laboratory, 6:30–9:30 P.M., per week.

C-33 and C-34 College Chemistry. Two semesters of Inorganic Chemistry, open to those who have passed C-32 or a satisfactory course in high school Chemistry. Two lectures, 7–9 P.M., and one laboratory, 6:30–9:30 P.M., per week. College level; 5 credit hours per semester.

C-35 Qualitative Analysis. The systematic analysis of inorganic compounds, carried out by the student in the laboratory using semi-micro technique. Chemical calculations and the balancing of chemical equations are covered in the stoichiometry portion of the course. One lecture, 7–9 P.M., and two laboratories, 6:30–9:30 P.M., per week. College level; 4 credit hours.

C-36 and C-37 College Quantitative Analysis. The basic principles of gravimetric and volumetric analysis with sufficient laboratory work to enable the student to become proficient in performing routine analysis. One lecture, 7–9 P.M., and two laboratories, 6:30–9:30 P.M., per week. College level; 4 credit hours per semester.

C-38 Organic Chemistry. A study of the important classes of carbon compounds and the fundamental theories of Organic Chemistry.

C-39. Technology of Fibers. The basic physical and chemical properties of natural and synthetic fibers.

C-41. Quantitative Analysis. One semester of quantitative analysis for those not desiring college credit in Chemistry but who wish to develop laboratory skills and techniques of a practical nature. One lecture, 7–9 P.M., and two laboratories, 6:30–9:30 P.M., per week.

C-42 Textile Quantitative Analysis. A continuation of C-41. The analysis of materials used in textile mills, dye houses and finishing plants, with emphasis on the practical techniques used in the analysis of bleaching agents, industrial water, soap oils and synthetic detergents.

ENGINEERING

Prof. Herbert J. Ball, S.B., B.C.S., F.T.I., *Chairman of Division*

GENERAL ENGINEERING, ELECTRICITY, AND ELECTRONICS

Prof. Herbert J. Ball, S.B., B.C.S., F.T.I., in charge
Prof. Harry C. Brown, B.S.
Assoc. Prof. Maurice E. Gelinas, S.B., A.M.
Asst. Prof. J. Arthur Ainsworth, B.S., M.S.
Asst. Prof. James W. Bell
Asst. Prof. Andrew A. Ouellette, B.S.
Mr. Stanley T. Athas, B.S., Development Engineer, Shawmut Engineering Co., Dorchester
Mr. Louis C. Block, B.S., Ed.M., Instructor, L.T.I.
Mr. A. E. Brownrigg, Quality Control Engineer, Sprague Electric Co., Nashua, N. H.
Mr. Albert L. Carpentier, B.S.
Mr. Francis L. Dacey, A.B., Supervisor, Courier-Citizen Co., Lowell
Mr. Robert K. Devejian, B.S., Instructor, L.T.I.
Mr. Jack L. Fink, B.S., Design Engineer, General Electric Co., Lynn
Mr. Thomas F. Galvin, B.S.E.E., Supervisor, General Electric Co., Lynn
Mr. Walter J. Grondalski, B.S., M.Ed., Biology Dept., Lowell High School, Lowell
Mr. Maurice W. Harrison, B.T.E., Quality Control Supervisor, Mass. Mohair Plush Co., Inc., Lowell
Mr. David K. Hines, B.S.M.E., Production Design Engineer, Department Head, The Calidyne Co., Winchester
Mr. Kenneth Hird, A.M.E., Mechanical Engineer, Raytheon Mfg. Co., Newton
Mr. Frederick K. Hussey, Jr., B.S., Standards Engineer, Raytheon Mfg. Co., Newton
Mr. Stuart P. Jackson, P.E., B.S.E., Supervisor, General Electric Co., Lynn
Mr. Herbert A. Kelley, Design Engineer, Charles T. Main, Inc., Boston
Mr. Thomas F. McElligott, A.B., Ed.M., Instructor, Lowell High School, Lowell
Mr. Arthur Peters
Mr. Kenneth L. Rogers, B.S., Instructor, L.T.I.
Mr. Roland L. Roy, L.T.I.
Mr. Edward N. Sabbagh, S.B., Instructor, L.T.I.
Mr. Samuel J. Sabbagh, B.S., Buyer, Independent Lock Co., Fitchburg
Mr. Sidney E. Stirk, B.S., Design Engineer, Improved Machinery, Inc., Nashua, N. H.
Mr. Chester Whitney, Landscape Gardener and Florist

LEATHER ENGINEERING

Prof. Albert E. Chouinard, B.S., M.S., Ph.D., in charge
Asst. Prof. Louis W. Stearns, B.S., A.M.
Mr. Alfred H. Mueller, B.S., Technical Director, American Hide & Leather Co., Lowell

PAPER ENGINEERING

Prof. John Lewis, B.S., M.S., in charge
Asst. Prof. Norwood H. Keeney, B.S., M.S.
Mr. Horace N. Lee, B.S., A.M., Instructor, L.T.I.

PLASTICS ENGINEERING

Prof. Russell W. Ehlers, B.S., M.S., Ph.D., in charge
Dr. George E. Murray, S.B., Ph.D., Head, Chemistry Section, Soil Fertilization Laboratory, Massachusetts Institute of Technology, Cambridge

First Semester Subjects (Sept.-Jan.)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
A. C. Machinery	E-36B	Tues. & Thurs.	E-45
Architectural Drawing	E-13E	Tues. & Thurs.	E-13B
Architectural Drawing	E-13F	Tues. & Thurs.	E-13E
Blueprint Reading	E-38	Mon. & Wed.	None
Calculus & Analytic Geometry	E-48	Tues. & Thurs.	Algebra & Trig.
Electric Circuits	E-44	Mon. & Wed.	Algebra
Electrical Circuits	E-45	Tues. & Thurs.	E-44
Electronics	E-43	Mon. & Wed.	College Math. & Physics
Fundamentals of Electronics	E-40	Tues. & Thurs.	E-45
Fundamentals of Plastics	E-51	Mon. & Wed.	None
Machine Shop Practice	E-14	Mon. & Wed.	None
Machine Shop Practice	E-15	Tues. & Thurs.	E-14
Mathematics	E-20	Mon. & Wed.	None
Mathematics	E-21	Mon. & Wed.	E-20
Mechanical Drawing	E-13A	Mon. & Wed.	None
Mechanical Drawing	E-13B	Tues. & Thurs.	E-13A
Mechanical Drawing	E-13C	Tues. & Thurs.	E-13B
Mechanical Drawing	E-13D	Tues. & Thurs.	E-13C
Mechanism	E-30	Tues. & Thurs.	None
Oil Heating	E-35	Mon. & Wed.	None
Practical Leather Chemistry and Laboratory Technique	E-60	Mon. & Wed.	Permission of Instructor
Pulp & Paper Technology	E-1	Tues.	None
Pulp & Paper Testing Laboratory	E-3	Wed.	E-1, concurrently
Quality Control	E-46	Tues. & Thurs.	See description
Shop Mathematics	E-19	Tues. & Thurs.	None
Steam	E-22	Mon. & Wed.	None
Textile Testing	E-71	Tues. & Thurs.	None

Second Semester Subjects (Jan.-May)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Advanced Paper Technology	E-2	Tues.	E-1
Air Conditioning — Heating & Ventilation	E-34	Mon. & Wed.	None
Architectural Drawing	E-13E	Tues. & Thurs.	E-13B
Architectural Drawing	E-13F	Tues. & Thurs.	E-13E
Blueprint Reading	E-38A	Mon. & Wed.	None
Calculus & Analytic Geometry	E-49	Tues. & Thurs.	E-48
The Chemistry of Plastics	E-50	Thurs.	College Chemistry through Organic
D.C. Machinery	E-36A	Mon. & Wed.	E-45
Diesel Engines	E-32	Mon. & Wed.	None
Electrical Circuits	E-44	Tues. & Thurs.	Algebra
Electrical Circuits	E-45	Mon. & Wed.	E-44
Fundamentals of Electronics	E-40	Mon. & Wed.	E-45
Geometry of Engineering Drawing	E-13G	Tues. & Thurs.	E-13D or E-13F
Industrial Electronics	E-41	Tues. & Thurs.	E-40

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Machine Shop Practice	E-14	Mon. & Wed.	None
Machine Shop Practice	E-15	Tues. & Thurs.	E-14
Mathematics	E-20	Mon. & Wed.	None
Mathematics	E-21	Mon. & Wed.	E-20
Mechanical Drawing	E-13A	Mon. & Wed.	None
Mechanical Drawing	E-13B	Tues. & Thurs.	E-13A
Mechanical Drawing	E-13C	Tues. & Thurs.	E-13B
Mechanical Drawing	E-13D	Tues. & Thurs.	E-13C
Meteorology	E-37	Mon. & Wed.	None
Physics	E-47	Tues. & Thurs.	None
Practical Leather Chemistry & Laboratory Technique	E-61	Mon. & Wed.	E-60
Principles of Radio	E-42	Mon. & Wed.	E-40
Strength of Materials	E-24	Mon. & Wed.	None
Textile Testing	E-71	Mon. & Wed.	None

Suggested Program of Studies

Recommended subjects for students interested in machine design are:

- Shop Mathematics E-19
- Mechanical Drawing E-13A, B, and C
- Machine Shop Practice E-14 and E-15
- Mechanism E-30
- Strength of Materials E-24

Recommended for those interested in electronics are:

- Mathematics E-20 and E-21
- Electrical Circuits E-44 and E-45
- Fundamentals of Electronics E-40
- Industrial Electronics E-41
- Electronics E-43

Recommended for those interested in electrical machinery are:

- Mathematics E-20 and E-21
- Electrical Circuits E-44 and E-45
- D.C. Machinery E-35A
- A.C. Machinery E-36B

Subject Descriptions

E-1 Pulp & Paper Technology. The basic principles of manufacture of the common papermaking pulps, followed by a study of stock preparation and paper machine operation.

E-2 Advanced Paper Technology. Details of manufacture of various papers and their conversion to a useful end product. Guest lecturers supplement the regular staff.

E-3 Pulp & Paper Testing Laboratory. Laboratory work in the physical and chemical testing of pulps and papers.

E-13A, B, C, D Mechanical Drawing. Fundamentals of engineering drawing. The first semester covers lettering, use of instruments, geometric construction, ortho-

graphic projection, multi-view and pictorial freehand drawing. The second semester includes dimensioning, auxiliary views, cross sectioning, screw threads and working drawings. The third semester offers intersections, pictorial drawings and applications to sheet metal drawings. The fourth semester covers assembly drawings from details of parts and detailing from designers' assembly drawings.

E-13E, F Architectural Drawing. The first semester covers problems of detailing and alteration such as a young draftsman might encounter in an architect's office. The second semester takes up design of a small house including floor plan, elevations, sections, details, heating, plumbing and electrical drawings, as well as cost estimates.

E-13G Geometry of Engineering Drawing. The theory of orthographic drawing and the study of space relationships of lines, planes, and solids.

E-14, E-15 Machine Shop Practice. Metal working, including bench work, lathes, grinders, planers, shapers, presses, milling machines, care of tools, tool grinding, heat treatment, forging, use of special tools, etc. The classes are limited to 25 students.

E-19 Shop Mathematics. Topics from arithmetic, algebra, and trigonometry which are most useful in drawing and machine shop practice.

E-20 Mathematics. Algebra, including addition, multiplication, subtraction, division, factoring and fractions.

E-21 Mathematics. A continuation of E-20. Some of the topics treated are: graphical representation, linear equations, radicals, quadratic equations, logarithms, slide rule, and some trigonometry.

E-22 Steam. Heat generation, transmission, and utilization. Topics covered are: heat and its measurement, use of steam tables, types of boilers, engines and turbines, boiler and engine room accessories, testing, etc. Lectures and assignments.

E-24 Strength of Materials. Tension, compression, shear, cast iron, wrought iron, steel, timber, design of bolts, tie rods, columns, boiler shells, riveted joints, beam theory, torsional stresses, shafts, etc.

E-30 Mechanism. The principles involved in the transmission of force and motion through machines and mechanical devices. Topics covered are: mechanics, accelerated motion, moments of force, pulleys, belting, gears, cams, etc.

E-32 Diesel Engines. An elementary study of Diesel engines, their operation, and maintenance. Types of Diesels, fuel oils, fuel injection systems, combustion, cooling systems, application, maintenance, etc. Lectures and assignments.

E-34. Air Conditioning — Heating & Ventilation. The principles of air conditioning covering the fundamental laws, physical properties of the atmosphere, measuring instruments, heating, cooling, humidification and dehumidification systems, air filtration, refrigeration, etc. Lectures and assignments.

E-35 Oil Heating. Fundamentals of heating systems, oil burners, controls, installation, and service.

E-36A D.C. Machinery. The theory and operation of generators, motors, power plant switchboards, etc. Industrial application of D.C. machinery, parallel operation, etc. Laboratory work covers methods of operating and testing D.C. equipment.

E-36B A.C. Machinery. Topics include: application of instruments to A.C. circuits, alternators, transformers, power plant switchboards, induction motors, synchronous motors, single phase, polyphase (delta and three phase, four wire systems), etc. Laboratory work covers operation and testing of equipment.

E-37. Meteorology. The principles of meteorology. Weather instruments and observations, physics of the air, stability of air masses, weather fronts, theory of storms, weather maps and analyses, forecasting, and climate.

E-38 Blueprint Reading. The principles of mechanical drawing, *e.g.*, projections, sections, dimensioning, etc., necessary for the understanding of blueprints.

E-38A Blueprint Reading. Similar to E-38, but with emphasis on architectural, rather than engineering, blueprints.

E-40 The Fundamentals of Electronics. Topics include: vacuum tube theory, vacuum tube applications including rectifiers, power supplies, amplifiers, classes of amplifiers, voltage gain and power amplifiers, electronic instruments, etc. Lectures and laboratory.

E-41 Industrial Electronics. The theory and operating characteristics of gas and vacuum tubes, photo-electric cells, and the thyratron. Topics covered include: amplifiers, electronic relays and timers, thyratron applications, phase shifts, inverters, rectifiers, motor and welder control, textile and other applications. Lectures and laboratory.

E-42 Principles of Radio. Audio systems, microphones, loud-speakers, radio wave propagation, antennas, transmission lines, amplitude and frequency modulation, radio transmitters, modulators, detectors, receivers, tracking and alignment, servicing instruments, etc. Lectures and laboratory.

E-43 Electronics. A more advanced treatment of the fundamentals of electronics than E-40, offered for those who have completed college mathematics and physics. Topics included are: alternating current circuits, fundamental properties of thermionic and photoelectric tubes, amplifiers, rectifiers, oscillators, coupled circuits, and filters. College level; 3 credit hours.

E-44, E-45 Electrical Circuits. The fundamentals of direct and alternating circuits. Topics include: Ohm's Law, series and parallel resistance, power, magnetic fields, inductance, capacitance, impedance, etc. Lectures and laboratory.

E-46 Quality Control. This subject deals with the quality problem in manufacturing and approaches it through the use of statistical quality control. How to determine the true accuracy of a machine or process, how to distinguish between normal and abnormal variations in any process and how to use small sample plans for inspection are examples of topics covered. Prerequisite: Approval of the instructor. Normally requires two years of college or industrial experience. Statistics is not required. The class is limited to 25 students.

E-47 Physics. Elementary physics on the high-school level. Lectures and demonstrations.

E-48, E-49 Calculus and Analytic Geometry. The first semester covers differential calculus with the necessary analytic geometry; the second semester covers integral calculus. College level; 4 credit hours per semester.

E-50 The Chemistry of Plastics. The chemical structure of high polymers and their manufacture and preparation. The chemical reactions of plastics and their physical properties in relation to their chemical structure. This subject is designed for those in the plastics industry who desire to keep abreast of modern theory or broaden their background. College level; 2 credit hours.

E-51 Fundamentals of Plastics. An introductory study for those who wish to acquire a general knowledge of plastics. Classification, description, chemical and physical properties, uses, and methods of fabrication.

E-60, E-61 Practical Leather Chemistry and Laboratory Technique. The theoretical aspects of leather production coupled with a laboratory to carry out the planning of process control, material control, and product quality control. One section will be devoted to an intensive introduction to the histology of hides and skins and histological preparations.

E-71 Textile Testing. A study of the methods used in the determination of the physical properties of textiles and the interpretation of test data. Topics include: a consideration of textile fibers and their properties, testing machines, breaking strength, elongation, fabric structure, tearing strength, thickness, bursting strength, crimp, twist, regain, etc. Lectures and laboratory.

GENERAL STUDIES

Prof. John R. Robertson, A.B., A.M., *Chairman of Division*

ART

Prof. Vittoria Rosatto, B.S., in charge
Mr. George E. Bowring
Mrs. William G. Chace
Miss Margaret Donohoe
Mr. Edward W. Dooley
Mrs. William E. Kaknes
Mrs. William R. Kiernan
Mrs. Margaret A. Moriarty
Miss Antoinette W. Nault
Miss Arlene C. Redmond
Mr. John F. Vaughan

ENGLISH

Prof. Lester H. Cushing, A.B., Ed.M., in charge
Mrs. A. Stephanie Delaney, B.S., Ed.M.
Miss Margaret Delaney, B.S., Ed.M., Supervisor, Boston State Teachers College, Boston
Mr. Arthur F. Haley, Jr., B.S., M.Ed., Instructor, L.T.I.
Mr. Francis K. Neilon, B.A., Ed.M., Principal, Dracut School System, Dracut

MANAGEMENT AND SOCIAL SCIENCES

Prof. John R. Robertson, A.B., A.M., in charge
Prof. Richard W. Ivers, B.A., Ed.M.
Asst. Prof. Thomas A. Malloy, A.B., M.A., Lowell State Teachers College, Lowell
Mr. Wilfrid J. Brodeur, Bookkeeper, L.T.I.
Mr. Richard K. Donahue, A.B., LL.B., Attorney at Law, Lowell
Miss Joan M. Flanagan, B.A., Ed.M., Instructor, Haverhill School System, Haverhill
Mr. George C. Hedrick, Merchandise Manager, Bon Marche Inc., Lowell
Dr. Paul V. McLaughlin, Ph.B., Ph.L., Ph.D., Instructor, Lowell High School, Lowell
Mr. Xenophon D. Michopoulos, A.B., M.A., Director of Guidance, Danvers School System, Danvers
Mr. Milton Richards, Milton Richards Advertising Agency, Lowell
Mr. Charles G. Sampas, B.S., City Editor, Lowell Sun, Lowell
Mr. Britton W. Saterlee, B.S., Personnel Director, General Electric Co., Lowell
Mr. Anthony Valkevitch, Foreman

First Semester Subjects (Sept.-Jan.)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Accounting I	G-82	Mon. & Wed.	None
Appreciation of World Literature	G-10	Tues. & Thurs.	None
Backgrounds of Latin America	G-84	Wed.	None
Business Law	G-78	Tues. & Thurs.	None
Contemporary World Problems	G-58	Mon. & Wed.	None

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Costume Design	G-35	Tues. & Thurs.	None
English Composition	G-20	Tues. & Thurs.	None
Fashion Illustration	G-42	Tues. & Thurs.	G-13
Foremanship	G-53	Mon. & Wed.	None
Freehand Drawing	G-13	Mon. & Wed.	None
Freehand Drawing	G-13	Tues. & Thurs.	None
Industrial Psychology	G-81	Tues. & Thurs.	None
Industrial Relations	G-55	Tues. & Thurs.	None
Principles of Advertising	G-57	Tues. & Thurs.	None
Principles of Retailing	G-18	Tues. & Wed.	None
Principles of Salesmanship	G-56	Tues. & Wed.	None
Psychology	G-75	Mon. & Wed.	None
Show Card Design	G-14	Mon. & Wed.	None
Silk Screen Printing	G-26	Tues. & Thurs.	None
Vocabulary Building	G-16	Mon. & Wed.	None
Writing for Profit	G-86	Mon. & Thurs.	None

Second Semester Subjects (Jan.-May)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Accounting II	G-83	Mon. & Wed.	G-82
Appreciation of World Literature	G-11	Tues. & Thurs.	None
Costume Design	G-36	Mon. & Wed.	G-35
Criminology	G-22	Mon. & Wed.	None
English Composition	G-21	Tues. & Thurs.	G-20 or equivalent
Foremanship	G-53	Tues. & Thurs.	None
Life Drawing	G-40	Mon. & Wed.	G-13
Meaning and Use of Words	G-17	Mon. & Wed.	None
Modern Latin America	G-85	Wed.	None
Pastel Drawing	G-34	Mon. & Wed.	G-13
Principles of Retailing	G-18	Tues. & Wed.	None
Principles of Salesmanship	G-56	Tues. & Wed.	None
Show Card Design	G-15	Mon. & Wed.	G-14
Techniques of Leadership	G-23	Tues. & Thurs.	None

Subject Descriptions

G-10, G-11 Appreciation of World Literature. Designed to increase the student's enjoyment of great literature of all types. The first semester covers American literature and its historical background; the second semester takes up British and Continental masterpieces.

G-13 Freehand Drawing. Drawing in charcoal from casts and group arrangements of still life.

G-14, G-15 Show Card Design. The preparation of commercial signs. The first semester deals largely with lettering and elementary layouts; the second semester teaches more elaborate layouts and designs executed in tempera paints.

G-16 Vocabulary Building. A subject to help the student enlarge his vocabulary and improve his understanding and choice of words. Language roots and word evolution are also studied.

G-17 The Meaning and Use of Words. The exact meaning of words and how their proper usage can lead to clear and dynamic speech.

G-18 Principles of Retailing. Stores — types, location, and organization. Merchandise — purchasing, preparing for resale, promoting, selling, advertising and displaying. Record keeping, planning, and merchandising calculations.

G-20 English Composition. The basic elements of composition, including remedial English, grammar, sentence structure, etc.

G-21 English Composition. Writing for business and social purposes. Narration, description, reports, letters, etc.

G-22 Criminology. The study of crime as a social problem. The causes, characteristics and treatment of criminal behavior analyzed in non-technical language.

G-23 Techniques of Leadership. Designed to aid the industrial supervisor to relate his own behavior to that of the group under his supervision. The dynamics of leadership and of the group receive primary emphasis. The concepts, values, and limitations of democratic and authoritarian leadership are treated through case studies and textual readings. Leadership as expressed through inter-personal relationships, and the resolution of social conflict both by integration and the democratic process provide the practical basis for this subject.

G-26 Silk Screen Printing. Stencilling and printing on textiles and paper with the silk screen.

G-34 Pastel Drawing. Drawing in pastel from still life group arrangements.

G-35, G-36 Costume Design. The first semester studies methods of altering a commercial garment pattern to suit the requirements of any figure. The second semester deals with the drafting of original patterns.

G-40 Life Drawing. Drawing from the live model in charcoal or in pastel. Individual and class instruction in anatomy.

G-42 Fashion Illustration. Training in fashion illustration as applied to promotion and advertising display.

G-53 Foremanship. A study of foremanship principles and problems based on the Foremanship Management Conference Manuals of the National Foreman's Institute. It is designed to help men now acting as foremen in a more successful handling of their job and is conducted by the conference or seminar method, each man bringing in his own problems for analysis by the group. Some of the topics are: understanding people, the foreman as a leader, eliminating irritations, training workers on the job, getting along with the man above, eliminating waste, wage incentives, cost factors the foreman can control, etc.

G-55 Industrial Relations. The underlying principles of harmonious relations between employer and employee. Some of the topics covered are: company policies and the foreman, employee morale, grievances, wages, training, collective bargaining, unions, government regulations, arbitration, etc.

G-56 Principles of Salesmanship. The fundamentals of salesmanship: the psychology of selling, building a selling talk, showmanship, elements of successful selling, wholesale and retail salesmanship, etc. Lectures plus student participation.

G-57 Principles of Advertising. The fundamentals of advertising: psychology, copy writing, layout, production, testing, campaigns, etc. Lectures and assignments.

G-58 Contemporary World Problems. The present-day issues of the world — communism, nationalism, imperialism, socialism, secularism, etc. — as they pertain to the individual's intellectual, physical and emotional life in society.

G-75 Psychology. This course covers the fundamentals of psychology with particular reference to the group relationships of the individual.

G-78 Business Law. The basic legal principles of use to people in the conduct of their everyday affairs. Topics covered include contracts, mortgages, deeds, negotiable instruments, easements, conditional sales, partnerships and corporations.

G-81 Industrial Psychology. A human relations approach to the study of the operation of basic psychological principles in industrial situations. The subject is designed for foremen and other supervisory personnel, not professional psychologists. Emphasis is placed on the relationships between worker efficiency and behavior, attitudes, fatigue, frustration, morale, motivation, etc. Some attention is given to causes of accidents and accident prevention, and to the problem of labor turnover. Selected case studies supplement text readings.

G-82, G-83 Accounting I and Accounting II. The principles of accounting. The first semester deals with the preparation and interpretation of reports and statements of financial position. The balance sheet, profit and loss statement, theory of debits and credits, ledger, etc., are covered. The second semester carries the student into payroll and tax accounting, partnership and corporate records and the basic principles of cost accounting.

G-84 Backgrounds of Latin America. The political, economic, social and cultural history of Latin America, including the Caribbean and Mexico, from the Spanish conquest to 1900. Some of the major topics are: the Colonial System, Wars of Independence and the Monroe Doctrine. Particular emphasis is placed on the influence of the United States upon Latin America's growth and development. Wednesday evening, 6–9 P.M. College level; 3 credit hours.

G-85 Modern Latin America. A continuation of G-84 covering the history of Latin America from 1900 to the present day. Some of the major topics are: Dollar Diplomacy, the Good Neighbor Policy, economic development and the increasing importance of Latin America in world affairs. Wednesday evening, 6–9 P.M. College level; 3 credit hours.

G-86 Writing for Profit. Creative writing for commercial use. Stress is laid on the creation and development of ideas in journalism, feature articles, short stories, and other forms of commercial writing. Student discussion and analysis of their own writings will be a major portion of the work.

TEXTILE MANUFACTURING

Prof. James H. Kennedy, Jr., B.T.E., M.S., *Chairman of Division*

DESIGN, WEAVING, AND KNITTING

Prof. Vittoria Rosatto, B.S., in charge
Assoc. Prof. Russell M. Fox
Assoc. Prof. Edward L. Golec, B.S.
Assoc. Prof. Nathaniel E. Jones
Assoc. Prof. John L. Merrill, B.T.E.
Asst. Prof. Martin J. Hoellrich
Mrs. Lucy R. Weinbeck, B.T.E.
Mr. Albert T. Woidzik, B.S., Instructor, L.T.I.

TEXTILE FINISHING

Assoc. Prof. John J. McDonald, B.T.C., M.S., in charge
Assoc. Prof. Winford S. Nowell, B.M.E.

COTTON AND STAPLE SYNTHETIC YARNS

Assoc. Prof. John A. Goodwin, B.T.E., M.S., in charge
Asst. Prof. Clarence J. Pope, B.S., M.S.
Mr. Kenneth S. Merrill, B.S., Instructor, L.T.I.

WOOL AND STAPLE SYNTHETIC YARNS

Prof. James H. Kennedy, Jr., B.T.E., M.S., in charge
Asst. Prof. J. Frederic Burtt, B.T.E.
Asst. Prof. Michael J. Koroskys, B.S., M.S.
Mr. Russell L. Brown, B.S., Instructor, L.T.I.
Mr. James T. Simpson, Time Study Supervisor, Abbot Worsted Company, Graniteville

First Semester Subjects (Sept.-Jan.)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Cotton Design	M-28	Tues. & Thurs.	M-27
Cotton Yarns	M-11	Tues. & Thurs.	None
Cotton Yarns	M-13	Mon. & Wed.	M-12
Elementary Textile Design	M-51	Mon. & Wed.	None
Knitting	M-15	Tues. & Thurs.	None
Loom Fixing	M-24	Tues. & Thurs.	M-33
Power Weaving	M-33	Mon. & Wed.	None
Power Weaving and Warp Preparation	M-32	Tues. & Thurs.	None
Reprocessed and Reused Fiber Manufacture	M-3B	Mon.	M-1 (or equivalent) & M-2
Synthetic Yarn Manufacture on Woolen System	M-3C	Tues.	M-3A
Technology of Natural and Man-made Fibers	M-2	Mon. & Tues.	None

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Textile Mechanism and Calculations	M-1	Thurs.	None
Top Mill Organization	M-8	Thurs.	M-4
Woolen & Worsted Design	M-30	Tues. & Thurs.	M-29
Woolen & Worsted Finishing	M-10	Mon. & Wed.	None
Worsted & Synthetic Yarn Manufacturing	M-5	Wed. & Thurs.	M-4

Second Semester Subjects (Jan.-May)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Cotton & Synthetic Design	M-27	Mon. & Wed.	M-51
Cotton & Synthetic Finishing	M-18	Mon. & Wed.	C-38 & M-51
Cotton Yarns	M-12	Tues. & Thurs.	M-11
Synthetic Yarn Manufacture on the Cotton System	M-14	Mon. & Wed.	M-13
Tow to Top-Synthetic and Man-made Fiber	M-7	Thurs.	M-4
Wool & Staple Synthetic French Combing	M-6A	Thurs.	M-4
Wool & Staple Synthetic Top Manufacture	M-4	Mon. & Tues.	M-1 (or equivalent) & M-2
Wool & Staple Synthetic Yarn Manufacture on the French System	M-6B	Wed.	M-4
Woolen Design	M-29	Mon. & Wed.	M-51
Yarn Manufacturing by Woolen System	M-3A	Mon. & Tues.	M-1 (or equivalent) & M-2

Subject Descriptions

M-1 Textile Mechanism and Calculations. The mechanisms and mathematics required for an understanding of textile machines. Pulleys, cones, gears, levers, cranks, revolutions, surface speed, constants, ratio, proportion, formulae, slide rule, etc. Lectures and demonstrations.

M-2 Technology of Natural and Man-made Fibers. Types of sheep and wool. Wool buying, selling, grading, sorting, scouring. Other animal fibers such as mohair, alpaca, camel, vicuna, etc. Man-made fibers, such as rayon, nylon, orlon, etc. Identification, tests, uses, properties. Theory and basic principles of yarn making by all systems. Explanation of mule spinning, frame spinning, roller drawing, porcupine drawing, pressed felt manufacture, etc. Lectures and demonstrations.

M-3A Yarn Manufacturing by Woolen System. The conventional woolen yarn system of picking and blending, carding and spinning, on both the mule and frame. Machine descriptions, adjustments, settings, maintenance, and processing techniques. Lectures and demonstrations.

M-3B Reprocessed and Reused Fiber Manufacture. The sources of reclaimed fiber, the sorting of raw materials and the carbonizing of rags. Rag picking, lumping, shredding, and garnetting. The Wool Products Labeling Act. Lectures and demonstrations.

M-3C Synthetic Yarn Manufacture on the Woolen System. Problems of processing synthetic fibers into yarn on woolen system machinery. The basic properties of synthetic fibers, techniques of processing, machine set-up, and special adjustments. Lectures and demonstrations.

M-4 Wool and Staple Synthetic Top Manufacture. The manufacture of wool or man-made fibers, such as cut staple rayon or synthetics, into top using some or all of the following operations: worsted type carding, backwashing, open and intersecting gilling, Noble Combing, Warner Swasey Pin Drafters, Holdsworth Gill Reducers. Mostly lectures, but sample lots of wool or synthetic fiber or blends are usually run in the laboratory as time permits.

M-5 Worsted and Synthetic Yarn Manufacture. Yarn making of wool or synthetic fiber or blends on the modified Bradford or English type of machinery. Roller drawing machines, worsted spinning frames, twisters and winders are studied as well as the newer short cut systems using the Warner Swasey Pin Drafter, Holdsworth Gill Reducer, etc. Other spinning systems, such as the Bird System, American System, Ambler, Saco-Lowell Draftall, Whitin Super-Draft are studied. Lectures and demonstrations, and sample lots of synthetics and wool or blends of all types of fibers are made into yarn in the laboratory when time permits. Spinning covers all phases of flyer, cap, ring, direct and centrifugal systems. Production, scheduling and routing problems are discussed with actual mill procedures as subject matter.

M-6A Wool and Staple Synthetic French Combing. The combing of shorter wools or synthetics on the so-called French Comb. Advanced intersecting gilling and blending of wool with other fibers and blends of synthetics. Mostly lectures, but modern equipment is available in the laboratory and usually small lots of wool or synthetics or blends are run.

M-6B Wool and Staple Synthetic Yarn Manufacture on the French System. The manufacture of wool or synthetics or blends into a French worsted type yarn. Intersecting gilling, open gilling with rub aprons, French or porcupine drawing. Short cut French systems using Pin Drafters and super draft porcupines, French Frame spinning, ring and mule twisting, winding. Mostly lectures, but modern laboratory equipment is available for demonstrations and running sample lots.

M-7 Tow to Top — Synthetic and Man-made Fiber. This subject covers in detail the processes and operations necessary to make top or sliver from synthetic or man-made tow. A detailed study is made of the Pacific Converter, Perlok system, Saco-Lowell Direct Spinner, etc. Mostly lectures, but sample lots are run on a Converter as time permits.

M-8 Top Mill Organization. Methods of calculating unit costs, personnel, work loads, cost of top, machinery layouts, supervisory help, production engineering. The over-all picture of an integrated woolen and worsted mill is considered to show how the top mill fits into the complete picture. The top mill is considered in detail. Lectures only.

M-10 Woolen and Worsted Finishing. The finishing of both woolen and worsted cloths. Some of the topics covered are: burling, mending, fulling, washing, speck dyeing, carbonizing, gigging, napping, steaming, brushing, shearing, and pressing. Lectures and some demonstrations.

M-11 Cotton Yarns. First semester of cotton yarn manufacture. Properties and characteristics of raw cotton; cultivating, ginning and marketing of raw cotton; mixing, opening and picking, and carding.

M-12 Cotton Yarns. Second semester of cotton yarn manufacture. Combing, drawing, regular and long draft roving.

M-13 Cotton Yarns. Third semester of cotton yarn manufacture. Spinning, spooling, winding, and twisting.

M-14 Synthetic Yarn Manufacture on the Cotton System. The processing of staple synthetic fibers on the cotton system and the modifications of cotton type equipment to handle these fibers. The lectures are supplemented with laboratory work.

M-15 Knitting. Yarns, yarn sizing, and the manufacture of knitted fabrics and garments from all types of yarn.

M-18 Cotton & Synthetic Finishing. The methods of converting both cotton and synthetic fabrics from the gray to the finished state. All the major processes of both wet and dry finishing of these fabrics are discussed, including crease resisting, stabilizing, water repelling, flame repelling, heat setting, etc.

M-24 Loom Fixing. The timing of all different motions in the loom and remedies for improper settings. Box and harness chain planning and building. Lectures and laboratory.

M-27 Cotton & Synthetic Design. Cloth analysis and design beginning with plain fabrics and leading into stripes and plaids, plus the construction, yarn denier and filament count of various synthetic cloths.

M-28 Cotton Design. The design and analysis of more elaborate cotton fabrics, such as extra warp and extra filling figured cloths, corduroys, velvets, ply fabrics, Leno fabrics, etc.

M-29 Woolen Design. Cloth analysis and design, covering blanket, bathrobing, filling reversibles, extra warp and filling backs, figured effects, double cloths, plaid backs, triple cloths and four-ply fabrics.

M-30 Woolen & Worsted Design. This subject includes the more complicated fabrics, such as chinchilla, melton, and kersey, as well as suitings. Manufacturing costs of woolen and worsted fabrics are also covered.

M-32 Power Weaving and Warp Preparation. Warp preparation in all systems as well as the Draper and Stafford automatic looms. Lectures and laboratory.

M-33 Power Weaving. The more complicated looms are studied, including dobby and Crompton & Knowles looms, as well as the Warner Swasey weaving machine. Weaving is primarily on woolen and worsted fabrics. Lectures and laboratory.

M-51 Elementary Textile Design. Weaves of all types, from the plain weave through fancy and figured weaves. Harness draft and chain are worked out for each weave. Yarn numbering for all systems, including ply and fancy yarns.

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A STROBOSCOPIC STUDY OF SPINDLE BUMPER STRAPS

by

Albert E. Chouinard*

I. Introduction

The results of this study are of interest to anyone concerned with the operation of a drop box loom. In general, this type of loom is usually referred to as a Crompton & Knowles loom. The spindle bumper is an essential component of the picking motion of the various modifications of these looms which have been manufactured by this company. The three main classes of Crompton & Knowles looms are the W, or woolen series; the C, or cotton series; and the S, or silk series.

Drop box looms, as the name implies, employ from two to four box units which are integrated into the motion of the loom for the purpose of dispensing a multiplicity of shuttles. In view of this design, it is impossible to have the picker stick in the line of shuttle travel. This particular design thus requires that the picker stick travel on the back side of the lay-end. Further, the picker which extends into the drop box unit in order to contact the shuttle must be guided on a rod which will maintain horizontal linear motion. This necessarily requires that the stick operate loosely and unattached within the picker because of its angular motion.

In practice, it has been found to be convenient to arrest the forward motion of the picker and the picker stick by placing various bumper devices on the spindle rod which guides the picker. Further, the efficiency and economic feasibility of these devices has been inversely proportional to the speed of the loom. This condition has become most apparent in the C series and S series of looms where attempts to operate up to 175 picks per minute have brought to the fore many hitherto unnoticed factors.

It has become immediately evident that a rapidly accelerated picker stick, sharply decelerated by a picker to which it is not positively attached, will (1) suffer considerable strain and shock, and (2) transmit considerable of this shock and strain to its point of leverage, the shoe, and (3) abrade and otherwise chew and fracture its point or surface of contact with the picker.

Experimental evidence and statistical analysis in the field have definitely shown the above results of increased loom speed to be factual, in the form of increased vibration, broken picker sticks, pickers, picker motion parts, and even loom sides. It has also been suggested that the quality of the cloth woven under these conditions has proportionately suffered.

II. Purpose of Tests

It was felt that in order to evaluate correctly and properly the causes of the observed and recognized variations in these checking devices, a study made under dynamic conditions of operation would yield the most accurate results. It was desirable to determine what particular variations could be observed in the action of this unit due to the use of different materials and even different modes of construction. It was hoped that these observed variations could be correlated with recognized failures.

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*Professor and Head of the Department of Leather Engineering, Lowell Technological Institute.

Acknowledgment is made to the Textile Leather Division of the National Industrial Leather Association. sponsors of the project.

III. Materials and Methods

This series of tests was conducted using three different bumpers, all of standard and accepted construction. The first strap was of all-leather construction, 2-ply riveted, sewed and punched as per Crompton & Knowles specifications for the S-6 loom. One end of the strap when placed on the loom forms what is known as a wrap-around. The second strap was of identical dimensions except that it consisted of 2 plies of leather cemented to a reinforcing webbing. Bumper No. 3 consisted of a section of extruded rubber tubing about 3½ inches long. The latter was a modification used in competition with leather straps in recent years.

Each bumper was placed on an S-6 C & K loom, and a series of photographs was taken from the point in the cycle where the picker is just contacting the bumper through to the point where the picker is just breaking contact.

In this method of observation, the view point was parallel to, and on the same plane as, the bumper spindle. This allowed a complete and unobstructed view of the action of the loop-type straps, the desire being to determine in what manner and to what extent each bumper served its purpose. In a second method of observation, the view point was opposite but on a 45° plane above. This point of observation was selected to permit one to look down onto the bumper, the picker, and the stick. The desire or intent in this case was to determine the relative motion and change of motion of these items in each case.

The loom was operated at a speed of 172 picks per minute. The source of illumination was a Strobolume manufactured by General Radio Corporation and rated at 1/700,000 of a second flash duration.

The pictures were taken with a Leica IIIA 35 mm. camera equipped with a 90 mm. lens. The lens was set at an aperture between f5.6 and f6.3 and the shutter was wide open, using the duration of the flash to limit the time of exposure. The camera and lens were mounted on a sliding focusing attachment, and all exposures were made in a darkened laboratory.

LEATHER SPINDLE BUMPER STRAP

Seven-Hole, 2-Ply Leather with Fabric-Reinforced Center
Cemented Construction — Oval Holes
Strap Applied with Wrap-Around
View in Horizontal Plane

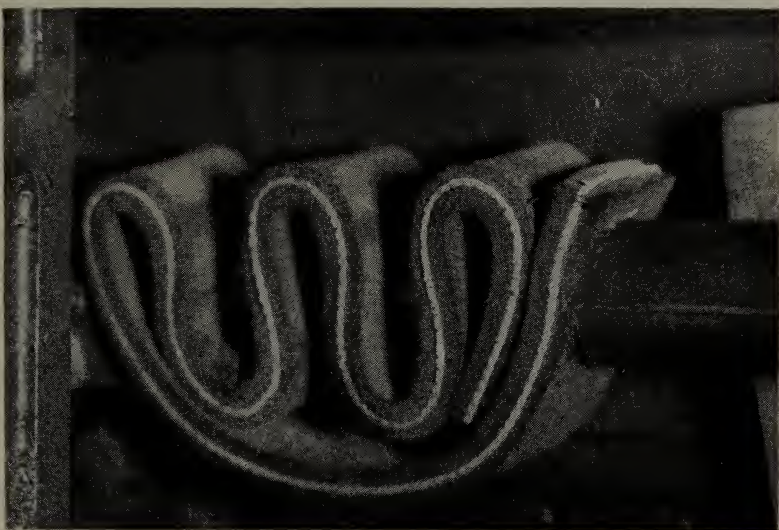

Photo 1

The picker is making contact with the strap and the first loop is just beginning to close. Note that the wrap-around portion of the strap is still not fully against the front of the picker.

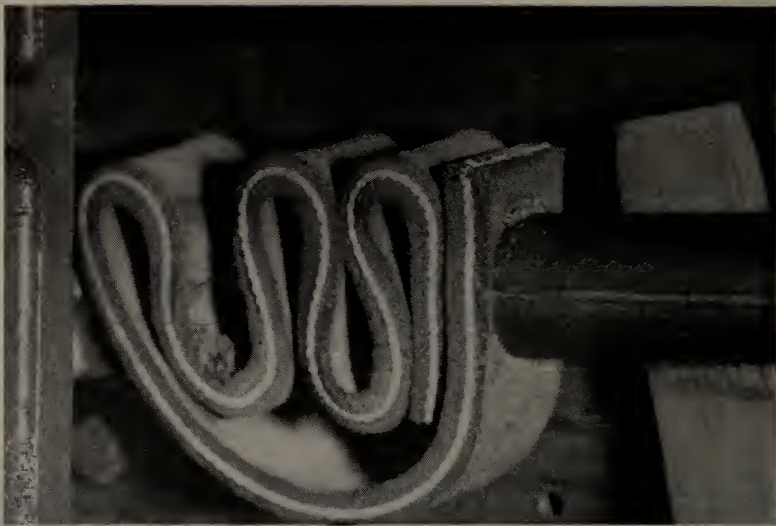

PHOTO 2
The strap is now beginning to absorb fully the force of the blow. The first two loops of the strap are closed; this indicates that there is successive absorption of the force of impact.

PHOTO 3
All of the loops are closed showing full contact, but the insides of the loops are still quite round showing that there is yet ability remaining to absorb more force. This seems to be the full extent of travel.

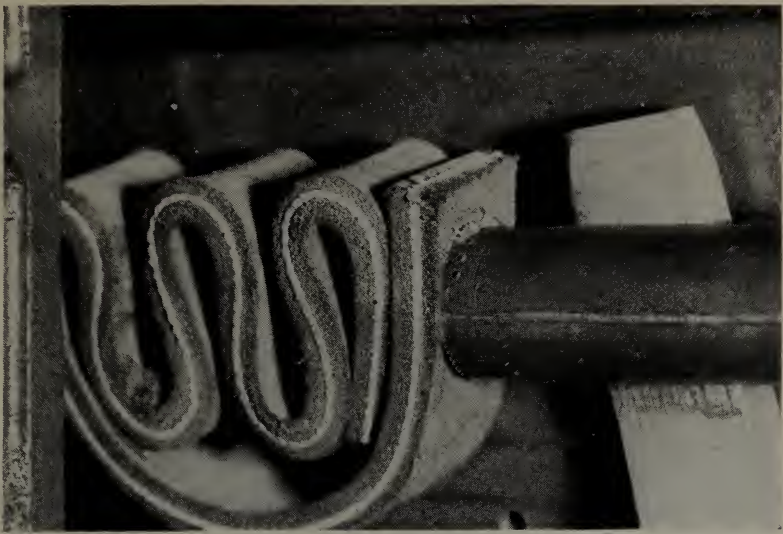

Photo 4

The stick is now returning and the loops are uncoiling evenly and *not* successively, indicating that the strap has absorbed kinetic energy which it can return to the stick driving it back. Also it recovers rapidly enough to remain in contact with the picker.

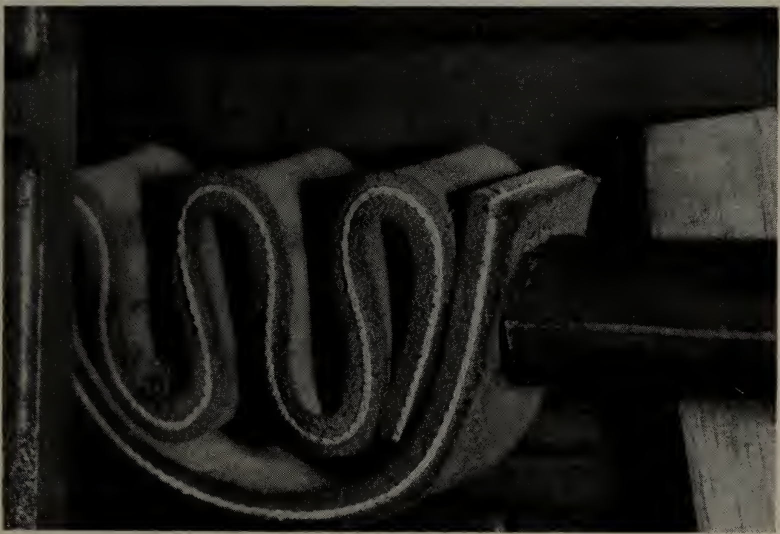

Photo 5

The strap is now fully relaxed, but still in contact with the picker, i.e., it is uncoiled and ready to absorb another blow. Note the extent of travel for the full absorption of the blow as indicated in pictures 1–3.

LEATHER SPINDLE BUMPER STRAP

Seven-Hole, 2-Ply Leather
Sewed and Riveted Construction — Round Holes
Strap Applied with Wrap-Around
View in Horizontal Plane

Photo 6
This picture of the leather strap originally supplied with this loom shows the picker just making contact with the strap. Note the lack of well-defined or rounded loops. The sides of the loops seem to be almost parallel.

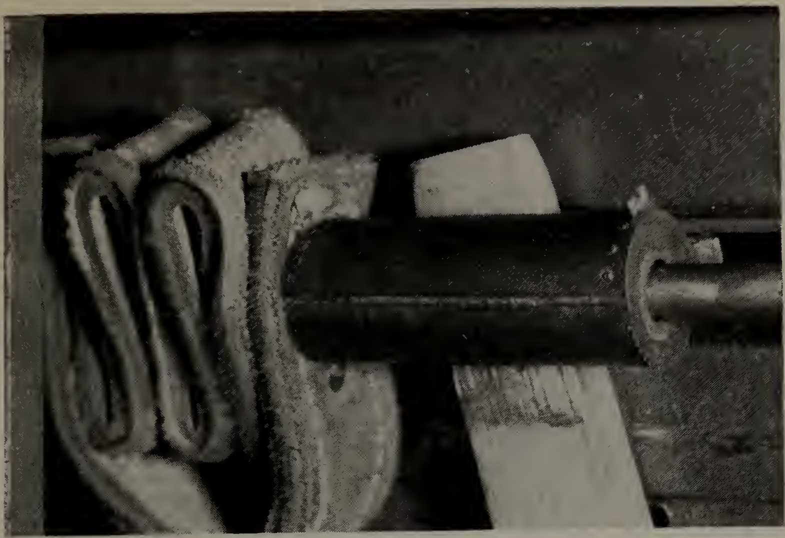

Photo 7
This picture indicates that the picker has traveled quite a distance for a small movement of the lay. This would indicate that little work was performed or absorbed by the strap between this and the previous position. There also does not appear to be any successive absorption between the loops.

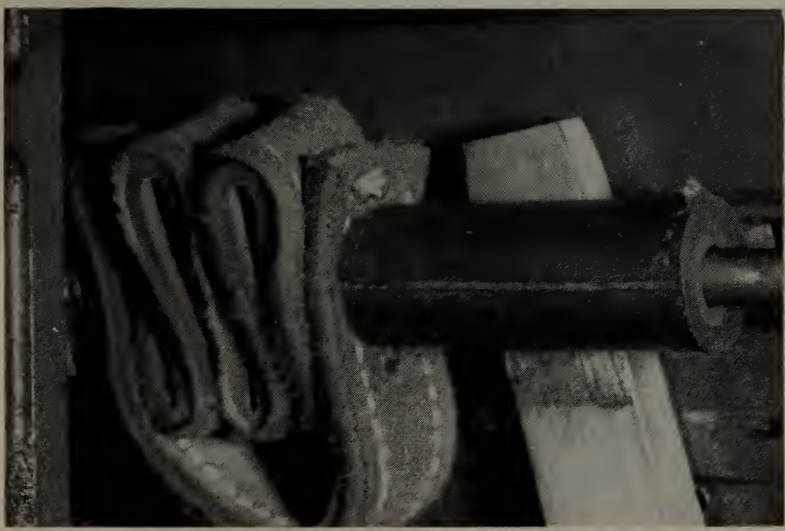

Photo 8
In this position the strap is fully compressed. The internal loops are small and poorly defined. It seems that much of the blow is being absorbed by internal compression of the leather along the axis of the rod.

Photo 9

The picker is now returning and the strap is recovering; as a matter of fact, it is almost fully recovered. This is shown by the opening between the wrap-around strap and the lower half of the picker face. There has been little lay motion between this and the previous picture.

Photo 10

The cycle of work is complete and the strap is fully released. The picker is already on its way back. Note the flattened appearance of the loops; flexing seems to be about a point or line rather than through a well-defined circle.

RUBBER SPINDLE BUMPER STRAP

Cut Four Inches Long and Applied with 7/32″ Thick
Leather Washers at Each End
View in Horizontal Plane

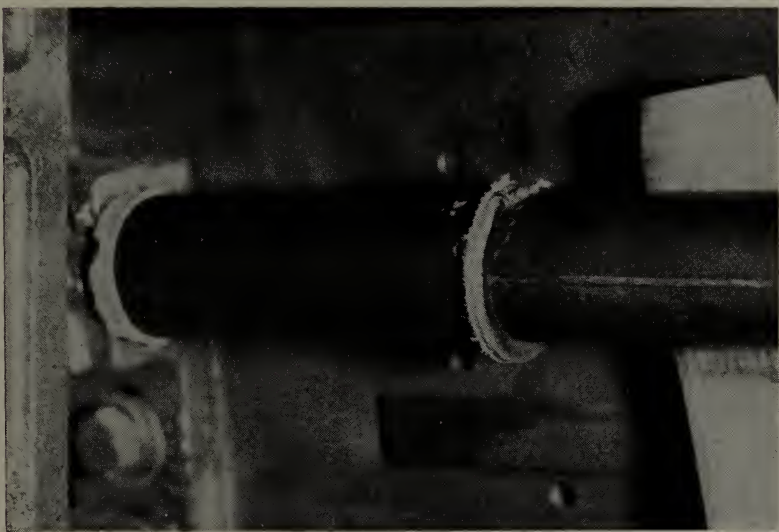

Photo 11

The picker has just made contact with the bumper, as the slight bulging at the forward portion of the bumper indicates. Measurement of this and of the succeeding picture indicates that at this first impact the stick has flown back within the picker slot.

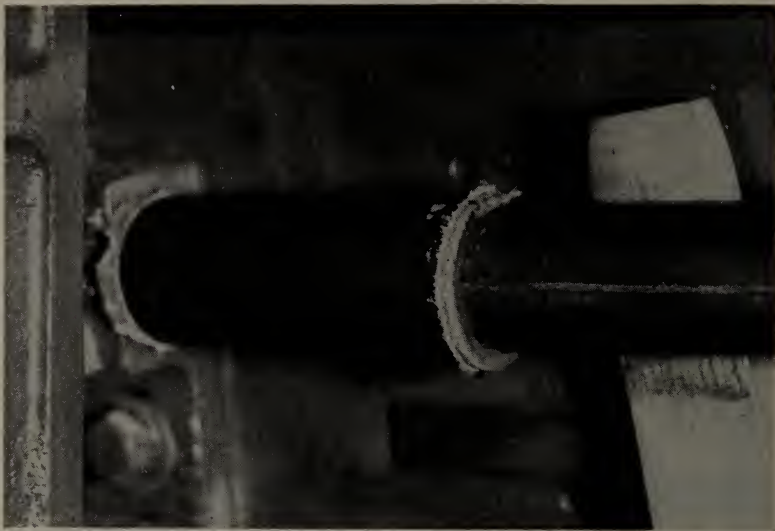

Photo 12
This seems to be the point of maximum travel and absorption. Note the swelling of rubber at the forward portion near the picker face. Also the stick has bounded forward again in the slot. Note the very small degree of forward travel of the lay.

Photo 13
The cycle is complete and the picker is returning. The stick appears to have again rebounded away from the face of the picker slot. There is very little travel of the lay throughout this last series.

LEATHER SPINDLE BUMPER STRAP

Seven-Hole, 2-Ply Leather with Fabric-Reinforced Center
Cemented Construction — Oval Holes
Strap Applied with Wrap-Around
View in 45° Plane

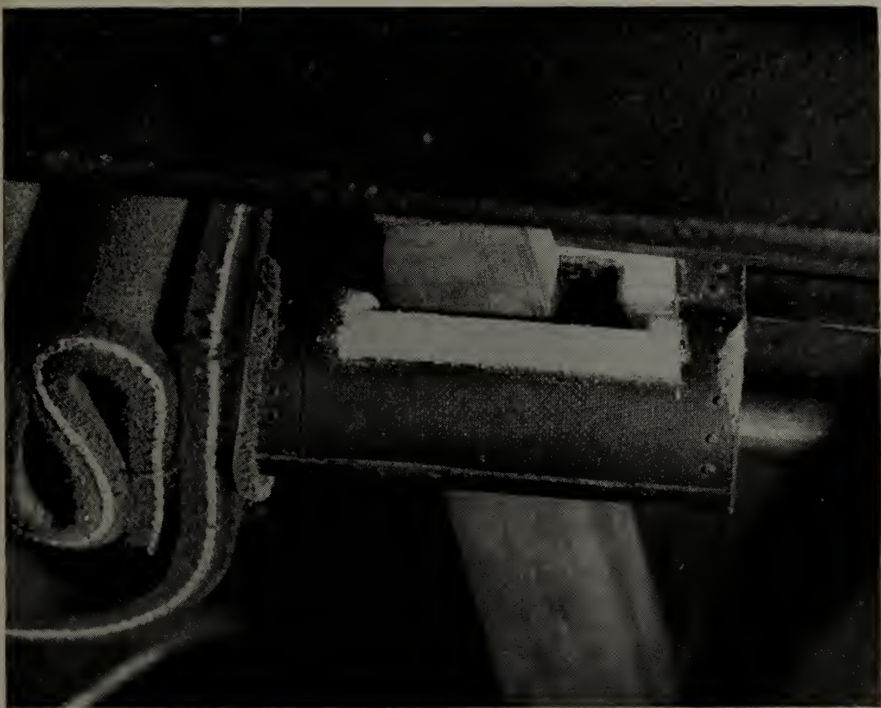

Photo 14

This photo corresponds quite closely to Photo 3 in Observation 1, Study 1, i.e., it is the point at which the strap is just beginning to absorb the overthrow of the picker and stick. The shuttle is already on its way into the other box. The picker-stick hole in the picker was painted white in order to outline its dimensions and also to create a background which would show up any movement of the stick within its confines. It can readily be seen that the picker drives into the bumper strap with appreciable travel taking place in the full absorption of the blow. In addition, it can be seen that the picker is decelerating at a greater rate than the stick, and thus the stick remains in contact with the forward edge of the hole.

Photo 15

The picker and picker stick are returning together with the bumper strap. This indicates that the strap has actually absorbed all the energy impressed on it when it stopped the picker and the stick. Further, it indicates that the strap is actually returning some of this energy to the picker and picker stick as they return to the other end of the rod. It is a similar action to the coiling and uncoiling of a spring as it absorbs a blow, for example, as in the coil spring in the front-end assembly of the average modern automobile. At no time in this portion of the cycle do the picker and picker stick separate; and a relatively gentle, buffered action is indicated.

RUBBER SPINDLE BUMPER STRAP

Cut Four Inches Long and Applied with 7/32″ Thick Leather Washers at Either End
View in 45° Plane

Photo 16
The picker is in direct and initial contact with the rubber bumper. In addition, the forward motion of the stick is greater and the stick is still in contact with the forward edge of the picker hole.

Photo 17

At this point in the cycle a slight forward motion of the lay is evident over that indicated in the previous picture. However, the picker is still in contact with the bumper, and no appreciable forward motion is indicated to show that the rubber bumper recoiled to absorb the blow. This lack of absorption by the rubber bumper is also evidenced quite clearly by the new position of the picker stick in the picker. The stick has been thrown away from the forward edge of the hole because of the abrupt halt of the picker. A second and separate motion is also observable, that of vibration. The stick has not only rebounded within the picker, but it is actually vibrating along its axis. Measurement of a point on the stick which shows up as a double image indicates that this vibration is of the order of $\frac{1}{16}$ of an inch in 7/100,000 of a second.

CONCLUSIONS

The first observations were taken primarily to indicate the smooth action of the S-type strap. A close study of each of these series indicates there might possibly be movement of the stick within the picker in certain cases. For this reason, it was finally decided to carry the work on to another step, i.e., to take a second observation under proper conditions to determine the relationship of the picker stick and picker with the bumper during the checking time. The following conclusions can readily be drawn from a study of these high-speed photographs:

1. The standard S-type strap absorbs the blow of the picker with a spring-like action; further, there seems to be full absorption of the blow, little, if any, being transferred to the picker stick. The energy which the picker has when it strikes the bumper strap and compresses it is used up as work and thus is not transferred to any other parts of the machine.

2. The loop action of the S-type strap seems to be excellent in all portions of the cycle of receiving and returning the picker; moreover, it seems to be adequate as there is every indication of additional reserve work capacity in the strap.

3. Reinforcement of the leather S-strap seems to improve it somewhat as the shape of the loops is more satisfactory and the action seems to be more rapid — a feature desirable in the higher speed looms. The ability of a bumper strap to receive the blow of the picker and recover rapidly enough to follow the picker back on the rod part way is quite important.

4. In the photographs of the rubber bumper, the blow is absorbed over a very short period of lay travel, which means a very small fraction of time.

5. This rapid return of the picker is due to the low order of compressibility as well as the short and rapid order of rebound of the rubber bumper.

6. The bumper actually returns practically all the energy of the system to the picker and picker stick, as little work is done on the bumper during the time that the abrupt reversing of the direction of travel takes place.

7. Rebound of the stick within the picker, as observed in the photographs, is no doubt the contributing factor to breakage of the picker as a result of the slamming action that takes place each time a pick is made.

8. The other motion, i.e., rapid vibration of the stick along its axis, indicates that the entire picker system is sustaining and absorbing a tremendous shock.

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THE MEASUREMENT OF THE FRICTIONAL AND FUSIONAL PROPERTIES OF TEXTILES AT HIGH SLIDING VELOCITIES

A project of the Lowell Technological Institute Research Foundation

By VASILIS LAVRAKAS*

INTRODUCTION

The study of the frictional and fusional properties of fabrics has received relatively little attention in textile research (1, 2)†. Although some effort has been made to relate the hand of textiles to basic frictional phenomena (3), for the most part frictional studies have been directed toward a better understanding of interfiber relationships rather than the behavior of the ultimate fabric (4, 5, 6, 7, 8). Fortunately, many of the basic concepts of friction, as evolved from studies of metallic and non-metallic substances, can be applied to textile structures.

The present study of fabric-to-fabric friction, sponsored by the Materials Laboratory, Wright Air Development Center, U. S. Air Force, under Contract No. AF 18 (600)-136, has been motivated by an interest to minimize frictional damage to nylon parachute fabrics. This damage occurs at deployment as a result of the rubbing of a parachute line passing at 70 to 140 feet per second over the canopy cloth. The relatively low melting point of nylon (480°F.) may be reached under these functional conditions of rubbing, leading to melting and tearing of the fabric at the point of contact. Figure 1 shows an example of the so-called "line burn" on nylon parachute fabric caused by fusion of the nylon under the severe frictional conditions often encountered in a parachute jump.

Since frictional heat can be lowered by reducing the coefficient of sliding friction, the use of lubricants as a possible remedial measure becomes apparent. In addition, by interposing between the two rubbing surfaces a sufficiently thick layer of a finishing agent of low coefficient of thermal conductivity (which many lubricants possess), the possibility of the melting point of nylon being reached may be further reduced. An instrument has been developed to measure the frictional and fusional properties of parachute structures and to evaluate lubricants under conditions simulating actual usage.

METHODS FOR THE STUDY OF FRICTION

Several methods exist for determination of the effect of the various parameters such as surface conditions, lubricants, and temperature upon the friction between two sliding surfaces.

In certain specialized cases (mainly in metallic studies) reliable theoretical formulations are available. These, however, are quite complex in nature and require precise data concerning all the factors affecting friction.

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†Numbers in this paragraph refer to works in the bibliography on the last page.

Friction may also be studied under actual operating conditions. This would generally be considered the most efficient procedure. In the particular situation of shroud line burns on a parachute canopy, such a procedure is both costly and hazardous.

The factors affecting friction, however, can be readily controlled and evaluated on a laboratory basis. Suitable apparatus can be devised for this study, and the results extrapolated to fit into the actual application. The true value of the laboratory study is then determined by applying the results obtained to end use conditions.

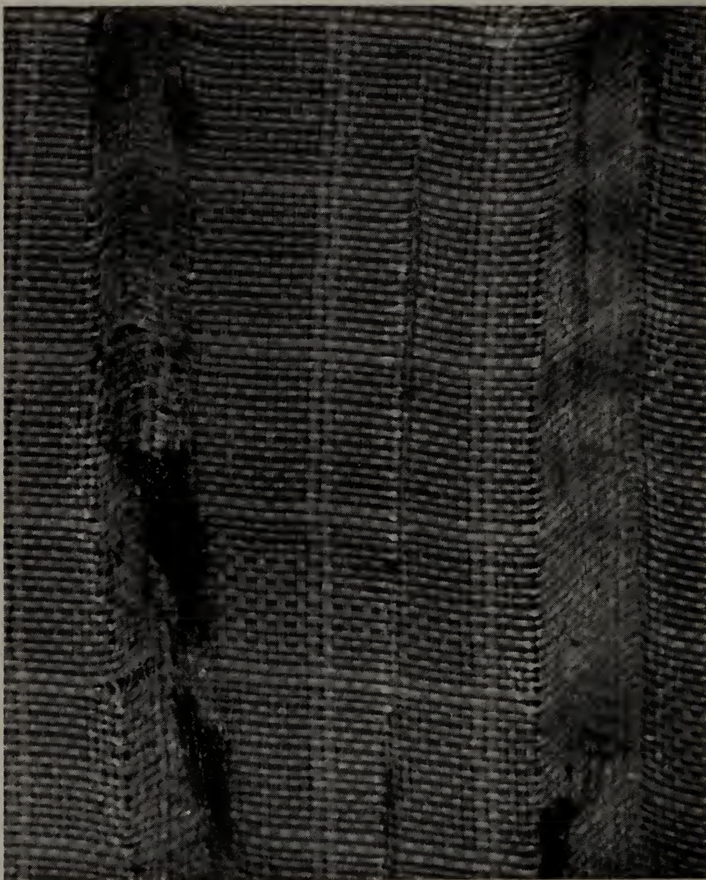


FIGURE 1

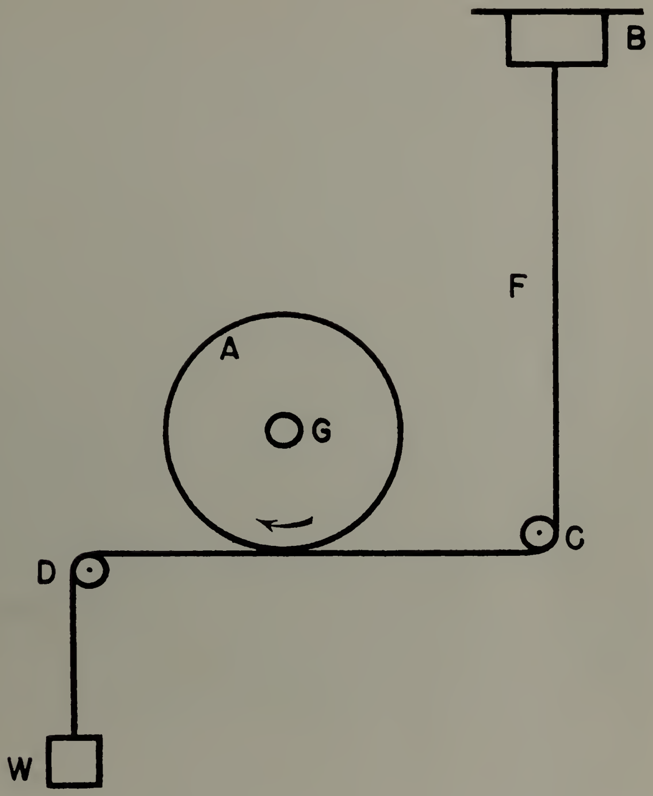
Partial damage (line burns) caused by improper deployment to nylon parachute canopy cloth, MIL-C-7020, Type I, Natural.

Two basic techniques are often used in the study of friction. In the first technique, the motion between the sliding surfaces occurs in a single plane as is the case in an inclined plane apparatus. The second technique utilizes the slipping of one material over a rotating cylinder having an appropriate

covering on its surface. This is called the belt friction apparatus and is most applicable to textiles.

INSTRUMENTATION

At the beginning of our project an apparatus was designed to simulate as closely as possible the conditions encountered in a parachute jump which produced the phenomenon of fusion and resultant tearing of the nylon canopy



HIGH SPEED FRICTION APPARATUS

FIGURE 2

cloth. This apparatus consisted of a spinning wheel upon whose outer periphery was mounted a length of nylon cord which was allowed to come into contact with a piece of parachute cloth. The cloth was ballooned by means of a jet of compressed air. When the spinning wheel and ballooned cloth came into contact, fusion should have occurred. Such was not the case, however, for neither the speed nor the load obtainable was great enough to cause fusion. Another drawback to this apparatus was the absence of a convenient method of measuring the frictional and fusional forces involved.

Upon further consideration it was felt that a duplication of the actual mechanical conditions producing line burns was not absolutely necessary. It is true that, in the case of the parachute, the area of contact would depend upon the depression made by the shroud line in the opened parachute. However, the character of the frictional phenomena should be constant as long as the shroud line was sliding across the surface of the fabric. Hence, why would it not be feasible simply to bring the shroud line into a sliding contact with

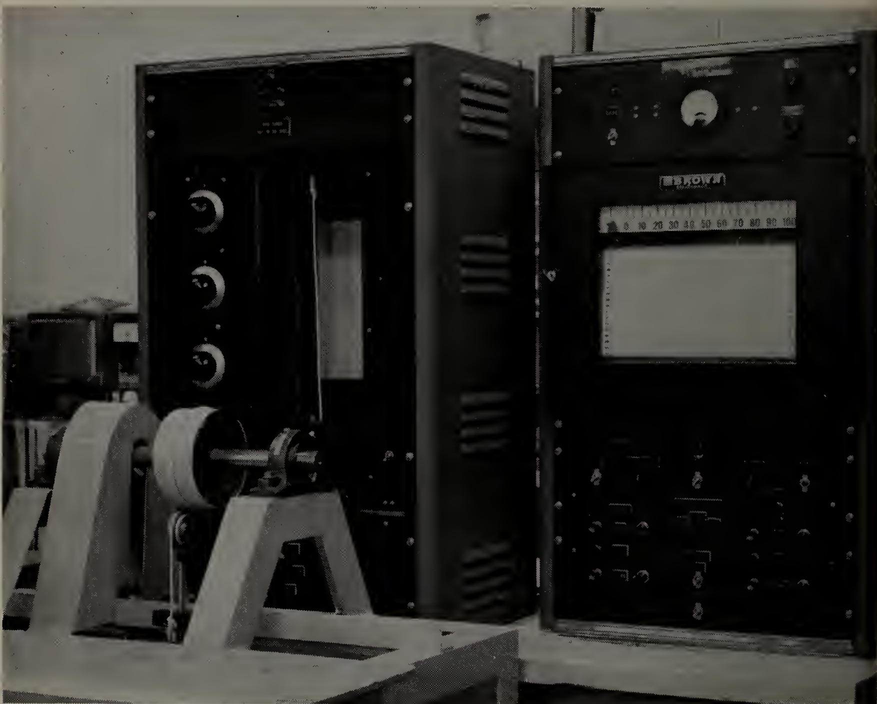


Figure 3

The Lowell Technological Institute Research Foundation apparatus for high velocity measurements of frictional and fusional forces of fabric on fabric.

the fabric and have the fabric supported on a solid surface? Furthermore, would not a lubricant which effectively reduced the friction between the shroud line and parachute cloth on such an apparatus have a positive effect in reducing the friction in the operation of the parachute?

As a consequence of this reasoning, a machine utilizing the belt friction principle was designed by Prof. Edward N. Sabbagh of the Lowell Technological Institute faculty. By means of this apparatus the fusion of sliding parachute fabrics was easily produced. In addition, from a knowledge of tensions and angle of wrap, experimental data on the frictional forces involved were also obtainable.

DESCRIPTION OF THE APPARATUS

The apparatus (Figs. 2, 3) consists of a cast iron pulley A, five inches in diameter and two and one-half inches in width, with a slit cut across its width

to accommodate the test fabric. A strip of parachute cloth is wrapped tightly around the pulley. The shroud line F is attached to the strain gauge B, drawn around pulley C, and wrapped around pulley A, to produce an angle of wrap of 360°. (The line may also be adjusted by a suitable arrangement of pulleys to produce an angle of wrap of 90°, 180°, or 270°.) The shroud line then

FIGURE 4

Fusional damage to nylon canopy cloth, MIL-C-7020, Type I, caused by the L.T.I. Research Foundation friction and fusion tester.

passes over pulley D and a weight W is suspended from the end of the line. Pulley A is attached to the drive shaft G which is motor-driven. Pulley A can be driven at peripheral linear speeds of 24, 35, 52, and 75 feet per second by means of a multiple pulley arrangement. The output of the strain gauge B is fed through an amplifier and recorded on a Brown "Electronik" potentiometer strip chart recorder. From this chart the sliding frictional force involved at any given time may be found.

METHOD OF TESTING

In the testing of scoured and unscoured parachute cloth and line, the sample of cloth is wrapped around the pulley with the warp yarns parallel to the edges of the pulley. Different samples of cloth are used for each test. The parachute cord is then wrapped over the cloth for the desired angle of contact. Slack tensions created by weight W are increased after each running time of 1.5 minutes at the desired speed. At high levels of slack tension the phenomenon of fusion appears. The fusing of the cloth and line is detected by an instantaneous increase in frictional force registered on the recorder as well as by the ripping of the cloth. Atmospheric conditions are maintained at 65% R.H. and 70°F.

In the testing of lubricants lengths of cord are dipped simultaneously into a solution of lubricant. The percentage pickup of a lubricant on each cord is calculated by a determination of the conditioned weight of the line before and after dipping. Generally, the lubricated line is tested against scoured cloth for 1.5 minutes at initial slack tension of 50 grams. After each period of running time the slack tension is increased on the same line and cloth, which are rubbed for another 1.5 minutes at the specified speed. This procedure is continued until fusion finally occurs. The slack tension at the time of fusion is referred to as the fusion point, FP, and is expressed in grams.

The experimental data obtained from the apparatus are utilized in the belt friction formula, $\frac{T_2}{T_1} = e^{\mu_k \theta}$, from which the coefficient of kinetic or sliding friction, μ_k, can be calculated. The tight tension, T_2, is found from the minimum force reading occurring at sliding on the recorder, minus the weight of the line from pulley C to the strain gauge. The slack tension, T_1, is the weight suspended from the lines plus the weight of the line from pulley D to the attached weight. The angle of contact or wrap, θ, can be found by use of a protractor.

REPRODUCIBILITY OF TEST DATA

The fusional damage produced on nylon parachute cloth by this apparatus is illustrated in Figure 4. The melted nylon, which appears along the edges of the openings in the nylon cloth, greatly contrasts with the appearance of the normal condition of the parachute fabric. The nature of the damage produced on nylon by the apparatus is similar to that which occurs in the actual parachute. This can be observed by a comparison of Figures 1 (an actual line burn) and 4 (a line burn produced in the laboratory).

Scoured and unscoured nylon parachute cloth (MIL-C-7020, Type I, 1.1 oz. per sq. yd., ripstop, natural) and scoured and unscoured nylon parachute cord (MIL-C-5040, Type III, natural) were studied for the effect of slack tension, T_1, upon tight tension, T_2. Table 1 contains the results of these tests.

On the scoured cloth and line, at a speed of 24 feet per second and an angle of wrap of 90°, coefficients of variation, V%, decrease from an initial value of 21.5% to 5.5%. At a speed of 35 feet per second, and under the same conditions of testing utilized at 24 feet per second, the coefficients of variation vary from a maximum of 23.8% at a slack tension of 8 gm. to a minimum of 10.5% at a slack tension of 13 gm.

However, with unscoured cord and cloth, which contain a small quantity of lubricants, the coefficients of variation at 24 feet per second generally are be-

low 10%, (Table 2). Such a result indicates that there is good reproducibility when some lubricant is present on the surfaces. This reproducibility of data was also found at higher speeds for unscoured cloth and line. In view of these results the study of lubricated line should produce data falling into a narrow range.

Variations in the range of values for T_2 as the slack tension increases cannot be explained at this time.

Table 1

EFFECT OF SLACK TENSION ON TIGHT TENSION
USING SCOURED PARACHUTE CLOTH AND LINE

Angle of Wrap (θ) = 90°
Temperature = 70°F.
Relative Humidity = 65%

T_1, gm	T_2, gm*	$\dot{\sigma}$	V%	μ_k
	Linear Speed = 24 ft. per sec.			
8	10.4	2.24	21.5	0.16
13	18.2	1.94	10.7	0.21
23	34.8	2.79	8.0	0.26
33	66.2	7.60	11.5	0.44
43†	81.4	4.34	5.5	0.40
	Linear Speed = 35 ft. per sec.			
8	10.6	2.83	23.8	0.18
13	22.8	2.40	10.5	0.30
18	32.8	6.57	20.0	0.38
23†	39.4	7.80	19.8	0.33

* Average of five tests
† Evidence of abrasive damage to the cloth
$\dot{\sigma}$ Best estimate of the standard deviation of the population of T_2
V% Coefficient of variation for T_2
μ_k Coefficient of kinetic friction

Table 2

EFFECT OF SLACK TENSION ON TIGHT TENSION
USING UNSCOURED PARACHUTE CLOTH AND LINE

Angle of Wrap (θ) = 360°
Temperature = 70°F.
Relative Humidity = 65%

Linear Speed = 24 ft. per sec.

T_1, gm	T_2, gm	$\dot{\sigma}$	V%	μ_k
22	73.8*	7.05	9.6	0.19
32	107.2*	9.40	8.8	0.19
52	204.2*	23.4	11.5	0.22
62	207.8†	18.9	9.1	0.20
102	291.0†	9.10	3.1	0.17

* Average of five tests
† Average of four tests, since one sample fused immediately
$\dot{\sigma}$ Best estimate of the standard deviation of the population of T_2
V% Coefficient of variation for T_2
μ_k Coefficient of kinetic friction

THE EFFECT OF LUBRICATION ON FUSION

Experimental results (Table 3) have proved that the presence of a lubricant on the cloth or line enables the attainment of higher speeds, slack tensions, and angle of wrap without resulting in fusion of fabric and cord. This was observed to be true for all lubricants studied, and therefore, as the presence of a lubricant essentially reduced the frictional heat, further work was pursued to separate good lubricants from relatively poor ones.

The separation of lubricants on an experimental basis was done by assuming that the slack tension at the time of fusion, i.e. fusion point, FP, is a true indication of the effectiveness of a lubricant. For example, butyl stearate applied to the line (5.7% pickup) and subsequently tested at 75 feet per second against scoured cloth was found to prevent fusion up to a slack tension of 132 gm. (FP = 132 gm.); while myristyl alcohol (5.8% pickup) under the same experimental conditions was found to prevent fusion up to a slack tension of only 51 gm. (FP = 51 gm.). Consequently, butyl stearate, because of its higher fusion point, was considered to be a better agent in the prevention of fusion.

As part of our program approximately 250 lubricants were tested utilizing the procedures previously described.

Table 3

THE GENERAL EFFECT OF INCREASING SURFACE FINISH UPON ANGLE OF WRAP, SPEED, AND FUSION POINT

Sliding Surfaces	Angle of Wrap, θ	Speed (max.) ft. per sec.	Fusion Point, FP, gm.
Scoured cloth and line	90°	35	23
Cloth and line as received from manufacturer	360°	52	32
Lubricated line and scoured cloth	360°	75	203

THE COEFFICIENT OF SLIDING FRICTION

From the studies made on the belt friction apparatus, it was also found that the coefficient of sliding friction does not necessarily remain constant with different slack tensions. For scoured material, the coefficient of sliding friction tends to rise with an increase in T_1 (Table 1). In the case of unscoured material, it tends to remain constant within the range of slack tensions studied (Table 2); while for those finishes which are good lubricants, i.e. which are effective in preventing fusion at high speeds (75 feet per second) and loads, results indicate that as the load increases at constant speed the coefficient of sliding friction tends to decrease. For example, for ethyl stearate the coefficient of sliding friction drops from 0.22 to 0.11 at slack tensions of 22 and 202 gm., respectively. All lubricants investigated show this same general trend.

Therefore, in this study of parachute fabrics, Amontons' Law, $\mu = \frac{F}{N}$, where F is the frictional force, N is the normal load, and μ is a constant of proportionality, apparently does not apply in all cases. Such a failure of Amontons'

Law also has been found in studies of fibers and yarns. Consequently, the relationship, $\frac{T_2}{T_1} = e^{\mu_k \theta}$, is not valid for our work, as μ_k is the same coefficient of friction which appears in the relationship of Amontons'.

The coefficient of sliding friction was originally considered to be a suitable parameter by which the effectiveness of the various lubricants could be evaluated. A lubricant with a low coefficient of friction would be expected to produce a minimum of frictional heat and thereby reduce the possibility of fusion of the nylon fabric.

Tests were initially run on various lubricants under the same slack tensions in order to obtain their coefficient of friction. Slack tensions were then increased to that value where fusion occurred. The experimental results indicated that the lubricant having the lowest coefficient of friction of the group tested at constant slack tension did not sustain the high tensions with any note of marked superiority. Since no definite correlation existed between the coefficient of friction and the maximum slack tension conditions, the coefficient of friction was eliminated as a criterion for selecting the better lubricants.

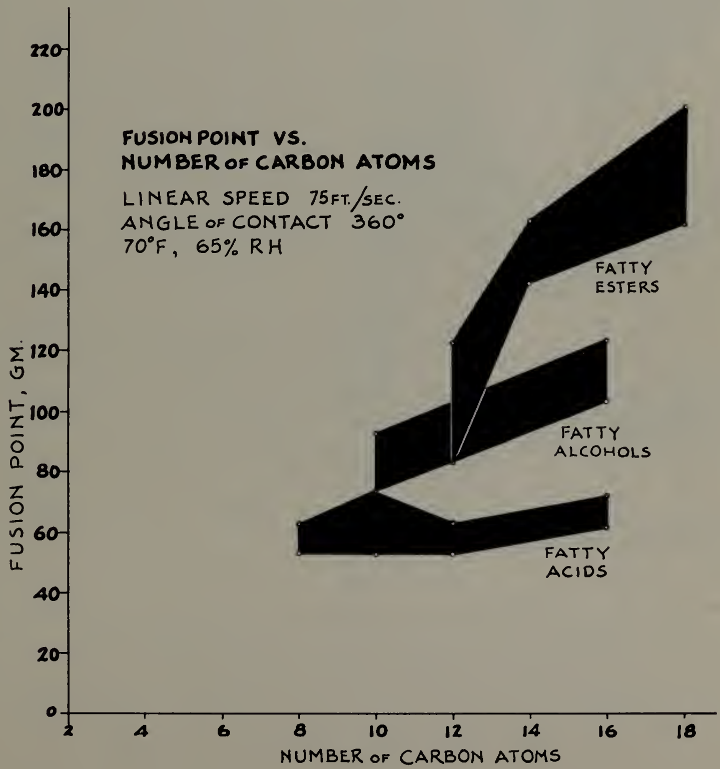


Fig. 5

THE RELATIONSHIP OF THE MOLECULAR WEIGHT OF A LUBRICANT AND THE FUSION POINT

A study of the chemical nature of the best lubricants, found in another phase of our program, showed that the majority were high molecular weight esters. To substantiate this finding and to observe the effect of molecular weight on the fusion point, a study was made of chemically pure fatty monoesters. Fatty acids and alcohols were also studied to relate changes in chemical structure to the effectiveness of the lubricant. A constant percentage pickup of 10 $\pm$ 1% was used for all lubricants studied. Figure 5 is a graph of the fusion points plotted against the number of carbon atoms of the lubricants studied at a speed of 75 feet per second. As these lubricants are members of a homologous series of straight chain compounds, it is possible to compare results within, as well as between, series. The range of fusion points is plotted, rather than average points, to give a more realistic view of the data.

For the fatty acids, the fusion point increases sharply in the range from eight to ten carbon atoms and then continues to increase at a slower rate to 18 carbon atoms. For the fatty alcohols, a more rapid increase occurs from 12 to 18 carbon atoms at higher levels of fusion points than for the fatty acids. In comparison to the fatty acids and alcohols, the fatty esters are best as fusion-preventing agents over the range of 14 to 20 carbon atoms. Thus, in fusion prevention, fatty esters are better in general than fatty alcohols, which in turn are better than fatty acids. The molecular weight range for all effective materials is between 200 and 300, with the highest molecular weight member of each series being the best lubricant.

Work was also done to study speeds other than 75 feet per second. The general trend for fatty alcohols and esters, at these speeds (25, 36, and 52 feet per second), was as expected: at each speed the fusion point increased with an increase in molecular weight.

However, the fatty acid curves (Fig. 6) are anomalous at the two lowest speeds investigated. At 25 feet per second an increase in fusion point is observed in going from eight to ten carbon atoms; between 10 and 14 carbon atoms a decrease occurs in fusion point; beginning at 14 carbon atoms an increasing trend in fusion point occurs once again. This type of curve, with a maximum at 10 and a minimum at 14 carbon atoms, is also obtained at a sliding velocity of 36 feet per second. The same type of curve might also have appeared for fatty alcohols and esters if a sufficient range of molecular weights had been studied.

An explanation for the types of curves obtained at low speeds is difficult to present. The interplay of factors other than molecular weight may be highly significant. Such factors as viscosity, vapor pressure, heat capacity, coefficient of thermal conductivity, and the presence or absence of hydrodynamic or boundary lubrication may be important. At higher speeds the curves indicate no maximum or minimum points. At these high speeds the same factors which exist at low speeds may be present, but the experimental procedures possibly are not sufficiently sensitive to detect any differences in fusion points. Further work must be done to establish a valid explanation which would account for the shape of these curves at low speeds.

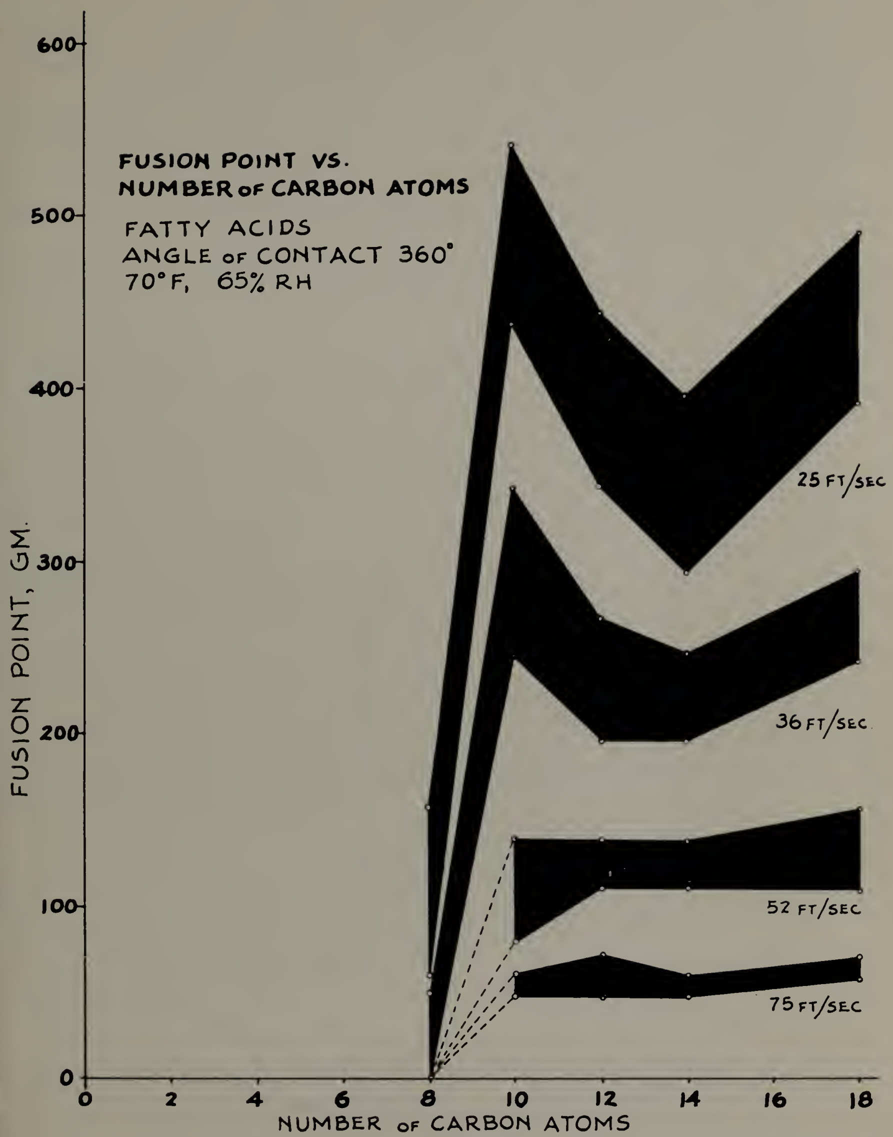

FUSION POINT VS.
NUMBER OF CARBON ATOMS
FATTY ACIDS
ANGLE OF CONTACT 360°
70°F, 65% RH
25 FT/SEC
36 FT/SEC
52 FT/SEC
75 FT/SEC
FUSION POINT, GM.
0
100
200
300
400
500
600
0
2
4
6
8
10
12
14
16
18
NUMBER OF CARBON ATOMS

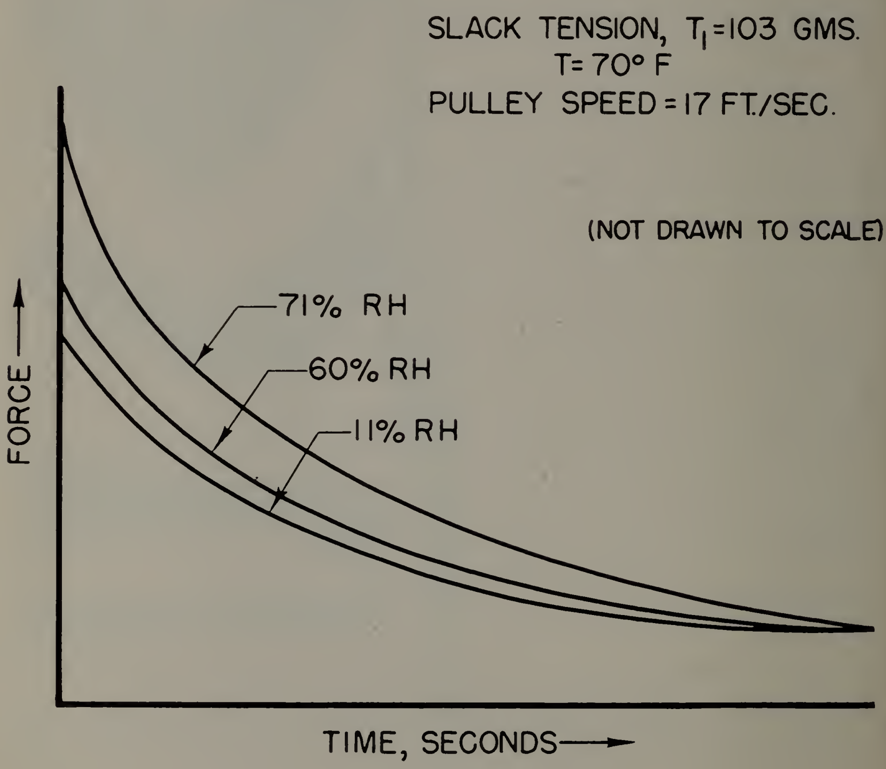
FIG. 6

THE EFFECT OF RELATIVE HUMIDITY ON FRICTIONAL FORCE

To observe the effect of relative humidity on frictional force, friction tests were made at relative humidities of 11%, 60% and 71%.

The data presented in Figure 7 show that at initial time the values of frictional force are higher than the values after running 1.5 minutes. The coefficient of sliding friction increases from 0.17 to 0.20 as the relative humidity changes from 11% to 71%. Nevertheless, after running 1.5 minutes, the frictional forces and the coefficients of friction reach the same value regardless of the difference in relative humidity.

These phenomena may be accounted for by assuming that frictional heat causes the fabric surface to dry to the same moisture level. Thus the fabric surfaces at the end of 1.5 minutes are alike for all samples, regardless of the ambient humidity. The conclusion, therefore, may be drawn that the friction of a drier fabric is less than that of a surface with a greater moisture content.



THE EFFECT OF RELATIVE HUMIDITY ON FRICTIONAL FORCE

FIGURE 7

SUMMARY

In this bulletin an apparatus for the study of friction and fusion of parachute materials based upon the belt friction principle is described. The effectiveness of lubricants in the prevention of fusion on parachute fabrics at high speeds has been studied and evaluated by means of this apparatus. In addition, the frictional forces of rubbing parachute materials have also been investigated.

The results show that scoured parachute materials have high frictional forces, and fuse at low loads and speeds. In the presence of an adequate amount (5 to 10%) of a lubricant, frictional forces are lower, and higher loads and speeds are possible before the appearance of fusion. Another interesting result of this work is the failure of Amontons' Law, $\mu = \frac{F}{N}$, both for scoured and highly lubricated materials; in the former case the coefficient of sliding friction increases with increasing load, and in the latter case the coefficient of sliding friction generally decreases with increasing load.

The study of the effect of relative humidity upon the frictional force reveals that an increase in relative humidity results in an increase of the coefficient of sliding friction. However, after 1.5 minutes of a test run, the coefficients of sliding friction decrease and reach the same value regardless of the ambient relative humidity. This result is attributed to drying of the fabric surface by frictional heat.

The nature of the ideal parachute lubricant has also been investigated. Results appear to indicate than an ester or ester-type material is the best type of lubricant to use in parachute lubrication. Its molecular weight should be above 300. Molecular weight may not be the only factor in lubrication. Viscosity, vapor pressure, heat capacity, coefficient of thermal conductivity, and the presence or absence of hydrodynamic or boundary lubrication may be of paramount importance. Further work must be done to identify these other possible factors in the development of the ideal parachute lubricant.

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55-'56

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The Institute reserves the right to make changes in the regulations, courses, and charges announced in this Bulletin.

INSTITUTE CALENDAR FOR ACADEMIC YEAR 1955-1956

1955

September 12, Monday, 9 A.M.	Freshman Orientation Week begins. Registration of Graduate Students begins.
September 15, Thursday, 9 A.M.	Registration of Upperclassmen.
September 16, Friday, 9 A.M.	Registration of Upperclassmen.
September 19, Monday, 9 A.M.	Undergraduate classes begin. Registration of Graduate Students ends.
September 20, Tuesday, 9 A.M.	Graduate classes begin.
September 30, Friday	Last day to register for new classes.
October 10, Monday	Columbus Day. Institute closed.
October 14, Friday	Last day to drop classes without penalty.
November 11, Friday	Veterans' Day. Institute closed.
November 23, Wednesday, 12 Noon to November 28, Monday, 8 A.M.	Thanksgiving recess.
December 16, Friday, 5 P.M. to January 2, 1956, Monday, 8 A.M.	Christmas recess.

1956

January 2, Monday, 8 A.M.	Classes resume.
January 23, Monday, 8 A.M. to February 1, Wednesday, 5 P.M.	First semester examinations.
February 7, Tuesday, 9 A.M.	Registration.
February 8, Wednesday, 8 A.M.	All classes begin.
February 17, Friday	Last day to register for new classes.
February 22, Wednesday	Washington's Birthday. Institute closed.
March 2, Friday	Last day to drop classes without penalty.
March 29, Thursday, 5 P.M. to April 9, Monday, 8 A.M.	Easter recess.
April 19, Thursday	Patriots' Day. Institute closed.
May 28, Monday, 8 A.M.	Second semester examinations begin.
May 30, Wednesday	Memorial Day. Institute closed.
June 8, Friday, 5 P.M.	Second semester examinations end.
June 18, Monday	Commencement exercises.

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David B. Morey, B.S., M.A., *Instructor*
Waldo W. Yarnall, B.S., *Instructor*

Department of Physical Education

Lester H. Cushing, A.B., Ed.M., *Professor, Director of Athletics*
David B. Morey, B.S.. M.A., *Instructor and Coach*
Waldo W. Yarnall, B.S., *Instructor and Coach*

Department of Social Sciences

John R. Robertson, A.B., A.M., *Professor, in charge of Department*
Stuart L. Mandell, A.B., M.B.A., *Assistant Professor*
Earl J. Watt, A.B., A.M., *Assistant Professor*
Arthur F. Haley, Jr., B.S., M.Ed., *Instructor*
John R. Sanders, A.B., M.B.A., *Instructor*

Division of Textile Manufacturing

James H. Kennedy, Jr., B.T.E., M.S., *Professor, Chairman of Division*

Department of Design, Weaving, and Knitting

Vittoria Rosatto, B.S., *Professor, in charge of Department*
Hermann H. Bachmann, *Professor Emeritus*
Russell M. Fox, *Associate Professor*
Edward L. Golec, B.S., *Associate Professor*
Nathaniel E. Jones, *Associate Professor*
John L. Merrill, B.T.E., *Associate Professor*
George G. Armstrong, Jr., *Assistant Professor*
Martin J. Hoellrich, *Assistant Professor*
Robert C. Gray, *Instructor*
Albert T. Woidzik, B.S., *Instructor*

Department of Fibers and Yarns

Chapin A. Harris, B.S., Ph.D., *Professor, in charge of Department*
Gilbert R. Merrill, B.T.E., *Professor Emeritus*
James H. Kennedy, Jr., B.T.E., M.S., *Professor*
John A. Goodwin, B.T.E., M.S., *Associate Professor*
Russell L. Brown, B.S., *Assistant Professor*
J. Frederic Burtt, B.T.E., *Assistant Professor*
Michael J. Koroskys, B.S., M.S., *Assistant Professor*
Clarence J. Pope, B.S., M.S., *Assistant Professor*
Kenneth S. Merrill, B.S., *Instructor*

Department of Textile Finishing

John J. McDonald, B.T.C., M.S., *Associate Professor, in charge of Department*
C. Leonard Glen, *Professor Emeritus*
Winford S. Nowell, B.M.E., *Associate Professor*

Department of Textile Testing

Jacob K. Frederick, Jr., B.S., *Associate Professor, in charge of Department*
David H. Pfister, B.S., M.S., *Instructor*

Other Officers and Assistants

Health Services

ARLENE D. GORDON, R.N.	*Resident Nurse*
(Local physicians and specialists as required)	

Library

JOSEPH V. KOPYCINSKI, B.S., M.S.	*Librarian*
RUTH A. FITZGERALD	*Library Assistant*
SHIRLEY A. DESMOND	*Library Assistant*
ROBERT L. DEIGNAN	*Library Assistant*
LORRAINE A. RICHER	*Library Assistant*

Administrative Assistants

HELEN G. FLACK, S.B.	*Executive Secretary*
THERESA D. LEBLANC	*Office of the Dean of Faculty*
ELIZABETH P. KENNEDY	*Office of the President*
MONA P. MACKENZIE	*Division of Chemistry*
KLEONIKE BENTAS	*Office of the Assistant to the President*
DOROTHY M. BELANGER	*Division of Engineering*
PAULINE J. DESMARAIS	*Division of Manufacturing*
RITA M. MCGRAIL	*Office of the Dean of Students*
ESTHER M. MCKINLEY	*Office of Admissions*
PATRICIA E. NICKERSON	*Division of General Studies*
JOAN F. SULLIVAN	*Division of Engineering*
MAUREEN A. SULLIVAN	*Receptionist*
WILFRID J. BRODEUR	*Office of the Bursar*
BARBARA M. JAROS	*Office of the Bursar*
JOSEPH H. LECAM	*Office of the Bursar*
ELEANOR M. MCKENNA	*Office of the Bursar*
EUNICE M. PALMER	*Office of the Bursar*
LORRAINE I. LEDOUX	*Office of the Registrar*
BARBARA JEAN MACCARON	*Office of the Registrar*
NORA M. MACBRAYNE	*Office of the Registrar*

Buildings and Power

CHARLES A. HENRY	*Chief Engineer*
JOSEPH A. NERNEY	*Superintendent of Buildings*

ALUMNI ASSOCIATION

The active membership of the Alumni Association of the Institute is composed of graduates of the day courses and is open to any non-graduate who has satisfactorily completed at least one year of the day curriculum. Membership also includes Associate and Honorary classifications.

The Association holds its annual business meeting and banquet in the spring of each year.

Communications should be addressed to Professor A. Edwin Wells, Executive Secretary, Alumni Office, Lowell Technological Institute.

Officers for the Year 1954-1955

Levon M. Yacubian, '26, *President*

Alden I. Gifford, '34, *First Vice President*

G. Harry Gwinnell, '25, *Second Vice President*

A. Edwin Wells, '20, *Clerk, Treasurer and Executive Secretary*

Ernest P. James, '42, *Assistant Secretary*

Alumni Fund Council

Evan H. Fairbanks, '35, *Chairman*

RESEARCH FOUNDATION

In recognition of the unique research opportunities afforded to industry by virtue of the equipment and staff available at Lowell Technological Institute, the Massachusetts State Legislature, in November 1950, authorized the establishment of the Lowell Technological Institute Research Foundation. Its purpose is to conduct research, development, and consulting programs under contract with responsible agencies and industrial organizations. This activity has the effect of permitting staff members access to new and significant developments in the textile and other industries and materially assists in keeping the teaching programs current and dynamic.

The Research Foundation provides the necessary mechanism whereby all of the research work of the Institute is brought under one coordinating office headed by the Executive Director. As in the past, however, the faculty of the Institute does the greater part of the research work. This plan has been proved through years of experience to be highly beneficial to both the Institute and industry.

The Foundation has the use of the Institute's laboratory and research facilities in chemistry, physics, engineering, textiles, electronics, paper, leather and plastics. The Institute has many unusual research facilities. These include a completely equipped laboratory for work with radio-active materials, an Instron tester, x-ray diffraction equipment, a large spectrograph, recording spectrophotometers, a pulse-propagation meter, and a completely equipped laboratory for microscopic work including phase microscopy and electron microscopy.

It is probably the only research organization in the world having at its disposal fully equipped laboratories to manufacture and finish nearly all types of fibers by all the common manufacturing systems as well as similar equipment for paper, leather and plastics processing. These splendidly equipped laboratories serve as pilot plants for the evaluation of industrial and manufacturing problems submitted to the Foundation.

The Foundation organization is built around the three basic divisions of Research, Development, and Testing, and is currently active in all three fields for both governmental agencies and industrial organizations.

For further information and descriptive literature about the Research Foundation, write to Professor John H. Skinkle, Executive Director, Lowell Technological Institute Research Foundation, 1 Textile Avenue, Lowell, Mass.

Lowell Technological Institute

GENERAL INFORMATION

History

Lowell Technological Institute was incorporated in 1895 and formally opened for the teaching of textile manufacturing subjects on January 30, 1897. It was then known as the Lowell Textile School and awarded only certificates and diplomas. Growth of the school in size, prestige, and scope of curricula was rapid, and in 1913 it was granted the right to give regular four-year degrees in textile engineering and textile chemistry.

In 1928 the name was changed to the Lowell Textile Institute to indicate more fully its collegiate status. Its continued growth resulted in further diversification of its areas of specialization and in 1950 it entered the fields of paper engineering and leather engineering. Electronic engineering was added in 1953 and plastics engineering in 1954.

In view of the present greatly expanded scope of its engineering program, its name was once more changed in 1953 to the Lowell Technological Institute. The Institute grants Bachelor of Science and Master of Science degrees and is authorized to set up a program leading to the doctorate.

Since 1918, when the property of the school was transferred to the Commonwealth of Massachusetts, it has been under the control and management of a Board of Trustees appointed by the Governor.

Accreditation

The Institute is a full member in the Senior College Division of the New England Association of Colleges and Secondary Schools. The United States Department of Education and the Armed Forces consider such membership equivalent to regional accreditation. The Engineers' Council for Professional Development extends full accreditation to the curricula in textile engineering.

Graduates of this Institute have been accepted for graduate study at nearly all leading universities. The Institute's prestige in its early field of specialization, textiles, has attracted students annually to L.T.I. from approximately 35 foreign countries.

Coeducation

The Institute accepts both men and women for entrance provided they are properly qualified graduates of an accredited secondary school. While the great majority of its students are

men, the Institute has attracted for some years a small but significant group of young women who recognize the increasing opportunities open to technically trained women in the various branches of chemistry and engineering.

Location

Lowell Technological Institute is located in Lowell, Mass., a city of 100,000, long famous as a textile center and more recently as a city of increasingly diversified industries. The campus is composed of ten main buildings located on a 15-acre site along the west bank of the Merrimack River and overlooking the rapids of Pawtucket Falls. The campus site was donated by Frederick Fanning Ayer, Esquire, and the Proprietors of the Locks and Canals on the Merrimack River.

Buildings

Southwick Hall. This was the first building erected on the present campus and was dedicated in 1903 as the gift of the Commonwealth of Massachusetts and Mr. Frederick Fanning Ayer. It is a memorial to Royal Southwick, an ancestor of Mr. Ayer and a leading textile manufacturer and public figure of his day. It contains the gymnasium, assembly hall, chemistry division and administrative offices.

Kitson Hall. Completed in 1903, Kitson Hall houses the cotton yarn, knitting, mechanical and electrical laboratories. It was erected by Charlotte P. Kitson and Emma K. Stott as a memorial to their father, Richard Kitson, founder of the Kitson Machine Company of Lowell.

Falmouth Street Building. Erected in 1903 as a one-story building, it was enlarged to its present capacity in 1907 by the Commonwealth of Massachusetts. Power weaving, woolen and worsted yarn, and filament yarn laboratories, as well as class rooms, occupy this section of the original quadrangle.

Louis Pasteur Hall. Originally constructed as a one-story building, it was enlarged to four stories in 1937 by the Commonwealth of Massachusetts. Most of the main chemistry laboratories, cotton finishing, textile testing and special research laboratories are contained in this area. It also houses the national research laboratories of the American Association of Textile Chemists and Colorists as well as the L.T.I. Research Foundation laboratories.

Paper and Leather Building. Completed in 1952 by the Commonwealth of Massachusetts, this modern building houses complete leather and paper manufacturing facilities, advanced textile testing and electronic laboratories, as well as many modern lecture rooms.

Alumni Memorial Library. Erected in 1951 by the Alumni Association through contributions from alumni and friends of the Institute, this modern library is dedicated to the men and women of the Institute who served this nation in World Wars I and II and the Korean conflict.

Besides a book stack capacity of 80,000 volumes, it contains student activity offices, alumni offices, reading rooms, typing facilities, micro-film room and faculty studies. It houses one of the most complete collections of textile books in the world and numerous special collections in the fields of paper, leather, chemistry, electronics, and plastics. It also serves as a depository for U. S. Government publications and is available to industrial concerns through its Industrial Corporate Membership program.

Cumnock Hall. Completed in 1954, this auditorium-administration building provides a 1,200-seat auditorium for academic convocations and social activities. It also contains the main administrative offices including those of the President and Assistant to the President, the Dean of Faculty and the Dean of Students, Graduate School, Admissions, Special Services, Placement, Bursar, Registrar, and offices of the L.T.I. Research Foundation.

Smith Hall. Erected in 1948 by the Lowell Textile Institute Building Association, Smith Hall has living accommodations for 112 students. The basement contains the college cafeteria and a medical dispensary. It is dedicated in honor of James T. Smith, pioneer educator in the textile field and the individual primarily responsible for the organization of the Lowell Textile School in 1895.

Eames Hall. The second men's residence hall was completed in 1949 by the Lowell Textile Institute Building Association and contains living quarters for 112 students, a student lounge and recreation center, and a snack bar. It is dedicated in honor of Charles H. Eames, President of the Institute from 1905 to 1945.

Equipment

The total value of the scientific and industrial equipment used in the instructional and research program of the Institute is approximately five million dollars. This equipment ranges from the most delicate scientific instruments, such as the electron microscope, to full-sized industrial machines.

The textile manufacturing equipment includes a full line of machines for processing any fiber, whether natural or man-made, on the cotton, woolen, French worsted, English worsted or American worsted systems. It also includes a modern throwing plant for filament yarns and a garnetting unit to reclaim used fibers.

All types of modern looms and knitting machines together with a full line of wet and dry finishing equipment enable the Institute to manufacture, under almost all industrial conditions, any type of fabric and finish desired.

The textile testing laboratories are among the most completely equipped in the world and have the use of the extensive optical and electronics facilities used in advanced research work.

In the completed equipped paper and leather laboratories both leather and paper of nearly all grades and types can be fully processed from raw materials, finished, and tested by the most modern methods, and an ambitious program of replacement of machinery is under way which will make the Institute eventually the finest equipped and most completely modernized of any in the country.

The wide variety of electronic equipment already available is in the process of being greatly augmented and consolidated in the new expanded electronics laboratories. The new plastics fabricating laboratories will be in operation by the fall of 1955 and will represent one of the few complete plastics laboratories in the country.

Complete mechanical, electrical and chemical laboratories of the usual types round out the unusual variety of equipment available for instruction and research.

ADMISSION OF UNDERGRADUATES

New students at the Lowell Technological Institute are selected from those applicants who, during their preparatory education, have shown evidences of promise in scholastic ability, strength of character, and leadership. In addition to scholastic rating and test results a high value is put on evidences of leadership and contributions to school and community life.

Application Procedure

Formal application for admission should be made as early as possible in the candidate's senior year of secondary school. Students from foreign countries are strongly advised to begin admission procedures not less than twelve months in advance of the expected date of enrollment.

Preliminary correspondence before the senior year is welcome and frequently helpful to the student in planning his secondary-school program to fit the needs of his freshman year at the Institute.

Requests for application blanks and all correspondence relating to matriculation at the Institute should be addressed to the Director of Admissions.

Steps to be taken for admission are:

1. Pages one and two of the admission application form should be completed by the candidate.

2. Attach a certified check or money order in payment of the application fee of $10. (See "Student Expenses" for explanation.)

3. The whole application form should then be submitted to the office of the candidate's secondary-school principal, with the request that his office fill out pages three and four and mail the completed application directly to the Director of Admissions.

It is recommended that this procedure be accomplished as soon as possible in the candidate's senior year in secondary school so that he may be considered for admission to classes beginning the next September.

4. All candidates for scholarships should make direct application to the College Entrance Examination Board, P. O. Box 592, Princeton, New Jersey, with a request to take the Scholastic Aptitude Test, described later in this section.

5. Each applicant must submit to a complete health examination by his family physician. A certificate of good health, indicating the date of this examination, must then be sent by the physician to the Director of Admissions. The Institute has prepared a spe-

cial form for the convenience of the physician; a copy of this certificate of health will be supplied.

6. A personal interview with the Director of Admissions is strongly recommended. The Office of Admissions at the Institute is open for this purpose Monday through Friday, from 8:30 A.M. to 4:00 P.M. during the school year. *It is urged that appointments for interviews be made in advance.*

Requirements for Admission

The Director of Admissions, in conjunction with the Committee on Admissions, reviews all applications to determine the eligibility of each candidate for matriculation. The final decision as to the eligibility of an applicant shall be left to the discretion of the Institute.

The conditions under which an applicant may be accepted are as follows:

1. A candidate for admission must be a graduate of a secondary school approved by the New England Entrance Certificate Board, the Regents of the State of New York, or a Board of equal standing.

2. (a) Because of the specialized nature of the various curricula at Lowell Technological Institute, it has been deemed advisable that all entering students shall have completed the following units of secondary-school study:

Algebra (quadratics and beyond)	2 units
Plane Geometry	1 unit
English	4 units
American History	1 unit
Chemistry (including laboratory)	1 unit
or	
Physics (including laboratory)	1 unit

Preference will be given to applicants offering both chemistry and physics. In addition to the above-listed prerequisites, each applicant must offer credit in elective subjects, such as languages, other than English; history, other than American; mechanical drawing; solid geometry; advanced algebra; scientific subjects; social studies, and others. Trigonometry is recommended but not required.

(b) The combined prerequisites and electives should total at least $15\frac{1}{2}$ Carnegie units. Each such unit of preparatory credit is the equivalent of one secondary-school subject satisfactorily pursued during one academic

year of at least thirty-six weeks of four forty-minute meetings each week, or the equivalent.

(c) In evaluating the credits offered by an applicant for admission, the Institute will be guided primarily by the quality of his scholastic record and by his apparent promise on grounds of intellect and character. Therefore, an applicant whose preparation has not followed the normal pattern with respect to the accumulation of unit credits should not hesitate to apply for entrance, provided that the quality of his scholarship gives evidence of ability to do college work and provided that he is recommended by his school. (For additional information, see paragraph "Exceptions to Admission Rules" below.)

3. All candidates for admission who are also applying for a scholarship must complete the Scholastic Aptitude Test which is prepared, administered, and graded independently of Lowell Technological Institute. Application to take the test must be made directly to the College Entrance Examination Board, P. O. Box 592, Princeton, New Jersey. Arrangements to take the test, which is scheduled annually for the early part of March, should be completed as early as possible in the candidate's senior year in secondary school.

Exceptions to Admission Rules—In special cases, at the discretion of the Committee on Admissions, applications may be accepted from candidates in the following categories:

1. Applicants who lack credit in specified required subjects because they are not offered in the course of study at their secondary school. Such applications will be considered only when the quality of work done in other departments is exceptionally high.

2. Applicants who offer credit in all the required subjects, but whose accumulation of unit credits does not total 15½. Very few students will find themselves in this category, because most secondary schools require at least 15½ units for graduation. However, the Institute is willing to recognize the possibility that a student, well-qualified in all other respects, should not be denied the opportunity to submit his application because of purely quantitative considerations.

Admission With Advanced Standing

Transfer students must submit transcripts of their college record, a copy of their college catalogue and letters of honorable dismissal well in advance of their planned transfer date. The

Director of Admissions and appropriate Department Heads will gladly advise prospective applicants concerning their plan of study.

Transfer credit will be given for courses satisfactorily completed that are the equivalent in quality and scope of those given at the Institute. Final decision on transfer credit rests with the Divisional Chairman in charge of the subject for which transfer credit is desired.

Special Students

Qualified applicants may be accepted for specialized work not leading to a degree. The plan of study should have a clearly defined objective and should not deviate markedly from the regularly formulated subject matter and laboratory courses at the Institute. Admission as a special student is contingent upon approval by the Director of Admissions and the Divisional Chairmen concerned in the proposed program.

Foreign Students

Each year Lowell Technological Institute accepts for admission foreign applicants up to 5% of the total number of students in any given class (freshman, sophomore, etc.). There are no special procedures to be observed by foreign candidates, although it is urged that they endeavor to have the transcript of their secondary-school and/or college records, as well as all other admission materials, submitted, in English, *not less than twelve months in advance of the expected date of enrollment.* All applicants should have a considerable facility in speaking and writing English, and have financial resources sufficient at least for their first year of study. Foreign students will be expected to complete the same schedule of courses as is assigned to all other students.

In all respects, the admission procedures for foreign students are identical with those required of U. S. citizens.

To facilitate their adjustment to the life of the campus, undergraduate foreign students are regularly assigned room space, shared jointly with American students, in the residence halls of the Institute. Students attending for the first time should note that towels, sheets, pillowcases, and blankets must be supplied by occupants of rooms. Students are therefore reminded that bedding, as well as clothing, should be suitable for a climate in which temperatures normally fall well below the freezing point during the winter months.

STUDENT HOUSING AND SERVICES

Residence Halls

All male students are required to live in the residence halls unless excused in writing by the Dean of Students. While such excuses are normally granted for the academic year, they are subject to review at the beginning of each semester and may be cancelled should conditions require.

Application for permission to occupy other living quarters will be made on special blanks available at the Dean of Students' Office. An application must be filed annually by each student. Deadlines for filing applications are: (a) for all new students (incoming freshmen, transfer students, special students, or graduate students)—on or before September 1 of each year; (b) for all regularly enrolled students—on or before June 1 of each year.

In granting special permission, the Dean of Students will give full consideration to the following:

a. Distance from Institute to place of legal residence.
b. Financial hardships involved in living in residence hall.
c. Year of the student, (freshman, sophomore, junior, senior, graduate).
d. Membership in fraternities that maintain a fraternity house.

Rooms are furnished by the Institute but are cared for by the students occupying them. Sheets, pillowcases, blankets, towels, and other personal linens must be supplied by each student. Each occupant is held responsible for any damage done to furniture and equipment.

Assignments of rooms in the residence halls are made through the Office of the Dean of Students. All assignments are for the full academic year. Change of room is not permitted except under unusual circumstances, and may be accomplished only after a formal application has been approved by the Dean of Students.

All rentals are uniform, the annual charge being $275.00 per academic year for each student. While this charge covers occupancy during periods that the Institute is regularly in session, it may, at the option of the Institute, be extended to vacation periods.

Assignments of rooms are made as equitably as possible and in the order that applications are received. For those students who are unable to be placed in residence halls, the Dean's Office supplies a list of approved rooming houses where students may reside.

Dining Hall

Dining facilities are provided on the campus in a cafeteria located on the ground floor of Smith Hall and a snack bar located in the Students' Lounge in Eames Hall. These facilities provide additional opportunities for the students to become better acquainted as well as assuring wholesome food and a balanced diet.

Guidance

A committee of faculty members supervises a guidance program which begins with the admission procedures, continues throughout the undergraduate years, and culminates in the work of the Placement Office.

Guidance in the freshman year stems mainly from the results of the diagnostic testing program, Freshman Week activities, the Effective Study Course and the work of the Faculty advisers. These advisers function throughout the freshman year. During the sophomore, junior and senior years the heads of departments and the Dean of Students take over the primary responsibility for the students' personal and scholastic guidance.

The Office of the Dean of Students is open to all undergraduates at all times to assist the student in attaining his academic objective, and to assure his active, enjoyable participation in the work and affairs of the Institute.

The Placement Office functions as a natural outgrowth of the undergraduate guidance program. This office endeavors to keep Institute undergraduates and graduates in constant contact with the latest developments in industry to insure placement in positions best suited to their talents and abilities.

Health Service

The Dispensary, in Smith Hall, is in charge of a registered nurse eight hours each school day. She is on call 24 hours daily, including week ends. Students receive first-aid treatment at the Dispensary, and are advised as to the best procedure in case of illness.

The college physician is on call 24 hours daily. If any student requires hospitalization, the college physician will arrange for admission to one of the three excellent, modern hospitals located in the immediate vicinity of the Institute. Medical fees and hospital charges are at the expense of the student.

Accident insurance during the academic year is compulsory and is included in the Activity and Insurance Fee. Sickness insurance is also available on a voluntary basis through the Office of the Dean of Students.

STUDENT REGULATIONS

Conduct

Students admitted to Lowell Technological Institute are assumed to be ladies and gentlemen, and of sufficient maturity and poise to enable them to live in an adult environment. Such living involves full respect for the rights of others, a regard for self-discipline and good order, and a high standard of honesty and of moral conduct.

In consequence of these assumptions, the regulations are framed not to restrict the conduct of individuals or groups of students, but, rather, to set forth the basic policies of the Faculty established in order that a large student body may live and work harmoniously together with a minimum of friction and misunderstanding. By the same token, even though the rules are neither detailed nor comprehensive, a student may be dropped from the rolls, or subjected to other disciplinary action, for conduct which is illegal, immoral, or inimical to the best interests of the Institute, regardless of whether or not the particular offense is listed in these rules and regulations.

Attendance

Attendance is expected of all students at all classes. The supervision of student attendance is lodged in the Office of the Dean of Students, both as to the announcement of detailed instructions and as to the enforcement of the rules established by the Faculty. Students charged with unexcused absences, particularly absences immediately before and after holiday and vacation periods, are subject to disciplinary action.

Disciplinary Action

Disciplinary action originates in the Office of the Dean of Students. Such action may be in the form of any of the following degrees of severity: Censure, Restriction, Suspension, or Dismissal. Whenever disciplinary action is taken, a notation of such action becomes a part of the permanent record of the student.

Academic Grades

The students' grades are reported by letter as follows:

A	90-100	F	Below 60, Failure
B	80-89	I	Incomplete
C	70-79	W	Withdrawn
D	60-69	X	Dropped

The student's semester rating is a weighted value used to denote his relative standing. The point values assigned are A = 4 points, B = 3 points, C = 2 points, D = 1 point and F = 0 points. These point values, when multiplied by the credit hours assigned to the subject and added together, are divided by the sum of the credit hours, to give the student's semester rating. The cumulative rating for more than one semester will be obtained in the same manner as the computation for the rating of a single semester.

Scholastic Reports

Reports of scholastic standing are compiled regularly at the end of each semester and formal notification of each student's status is made at that time.

Dean's List

The Dean's List is composed of those students who have a semester rating of 3.00 or higher, with no current failures.

Probation

A student is placed on probation when his semester rating is below 1.25. The probationary period covers the entire semester following the issuance of the semester rating which placed the student on probation.

A student with a rating of less than 1.25 for two consecutive semesters may be dropped from the Institute for at least one semester.

A student on probation may not represent the Institute in any public function and may not hold class or other offices during his term of probation.

If a student receives a semester rating below 0.50, he may be automatically dropped from the Institute without benefit of a probationary period.

REQUIREMENTS FOR GRADUATION

Only those students who have satisfied the following minimum requirements will be recommended for the baccalaureate:

(1) Complete successfully one of the prescribed curricula with no substitutions for major subjects therein and no unremoved failures in a major subject.

(2) Earn a cumulative rating of 1.5 or better for the entire period at the Institute.

(3) Pass 80% of the credit hours offered towards the degree with grades higher than D.

Graduation Honors

Academic honors are awarded at the annual Commencement Exercises by appropriate notation on the diplomas for the baccalaureate degree, and by printing in the commencement program the names of students who have earned such recognition. Honors are awarded according to the following standards of achievement:

a. Any student who graduates with a rating of 3.00–3.49 for the entire period of study at the Institute shall be awarded the baccalaureate degree *"With Honors"*.

b. Any student who graduates with a rating of 3.5 or better for the entire period of study at the Institute shall be awarded the baccalaureate degree *"With High Honors"*.

c. The highest ranking student in each graduating class who graduates with a rating of 3.8 or better, and who has completed at least six semesters of work at the Institute, shall be awarded the baccalaureate degree *"With Highest Honors"*.

STUDENT AWARDS

The following awards are made annually:

(1) *American Association of Textile Chemists and Colorists Book Prize*

Awarded to the outstanding graduating senior in the course of Textile Chemistry. The recipient is selected by the Chemistry Division and the academic standing of the candidate is an important factor. The award includes a junior membership for one year in the A.A.T.C.C.

(2) *American Association for Textile Technology Award*

Given annually to the member of the senior class, majoring in textiles, who is rated highest on the basis of scholarship, technical ability, industry, judgment, leadership, reliability, and ability to work with others.

(3) *Chemistry Department Award*

A book prize is awarded to the member of the freshman class who shows the highest achievement in Freshman Chemistry during the first semester.

(4) *National Association of Cotton Manufacturers Award*

Given to the member of the graduating class in Textile Engineering (General Manufacturing Option) or Textile Manufacturing who has maintained the highest scholastic standing throughout the four years of his undergraduate work.

(5) *Louis A. Olney Book Prizes*

Selected reference books are awarded annually to the outstanding freshman, sophomore, and junior students in the course of Textile Chemistry. The recipients are selected by the Chemistry Division chiefly on the basis of academic standing in chemical subjects.

(6) *Phi Psi Award*

Given annually to an outstanding member of the graduating class in a Textile course on the basis of scholastic standing, leadership, initiative, personality, loyalty, and courtesy.

(7) *President's Medal*

This award is made at Commencement to the student graduating with the most distinguished academic record in his class and *"With Highest Honors."*

(8) *Textile Veterans Association Honor Award*

This Association, representing all the veterans of World War II now affiliated with the textile and allied industries, has established an annual honor award, in the form of a suitably engraved bronze medallion. It is given to an outstanding graduating senior in a textile course on the basis of scholastic standing, extra-curricular activities, and over-all contribution to the Institute. Preference is given to veterans.

STUDENT EXPENSES

The various student expenses described in this section apply only to the regular day school of Lowell Technological Institute. The fees and expenses of the Evening Division are described in a separate bulletin. All fees are established by the Board of Trustees and are subject to change without advance notice.

Payment of tuition and fees is an integral part of the registration process which must be completed before a student may attend classes. In special cases a delay in the payment of fees may be authorized, but all fees *must be paid* on or before the close of the sixth week of classes of the semester involved. Requests for delay must be approved *before* a student's registration is complete.

Application Fee (first year of registration only) . . . $10

Payable by certified check or money order and filed with the Director of Admissions at the time of application.

a. If the applicant is accepted for admission and is duly enrolled as a student at the Institute, the entire amount of this fee shall be credited toward his tuition charges on the day of registration.

b. If the applicant is not accepted for admission as a student, the entire amount of this fee shall be refunded.

c. If the applicant is accepted for admission but does not choose to enroll as a student, no refund shall be made.

d. If the applicant is accepted for admission but is called to duty in the Armed Services of the United States, he shall, upon presentation of suitable evidence of this fact, be entitled to a refund of the entire amount of the application fee.

Tuition—The yearly tuition fees are:

Residents of the Commonwealth of Massachusetts	$150
Non-residents	$250
Foreign students	$500

Students who are classified by the United States Immigration Authorities as "Displaced Persons" will pay non-residents' tuition of $250.

Applicants for admission from territorial possessions or protectorates of the United States will pay the tuition fees established for non-residents.

Special students pay, in general, the full tuition fee. However,

if enrolled in only a limited number of courses, a special student may make application to the President for a reduction in tuition.

Residence

Because Lowell Technological Institute is a state-supported institution, its educational program and facilities are made available at a low tuition rate to students entering from the Commonwealth. Eligibility for admission as a resident entitled to the low residential tuition is determined under policies established by the Board of Trustees.

a. Every student claiming residence in Massachusetts must file with the Bursar a certificate signed by either the town or city clerk of the community claimed as legal residence, stating that the student's parents, or guardian, are legal residents of the Commonwealth of Massachusetts.

b. The residence of a minor shall follow that of the parents, unless the minor has been emancipated. A minor student who has been emancipated shall, in addition to the requirements respecting residence, present satisfactory documentary evidence of emancipation.

c. A minor under guardianship shall be required to present satisfactory documentary evidence of the appointment of a guardian in addition to the certificate of residence of the guardian.

d. The residence of any applicant for admission, as shown on the application for admission at the time of initial application, shall determine the appropriate tuition charge to be made for the entire period or periods of the applicant's enrollment as an undergraduate, graduate, and/or special student. Out-of-state students who accept employment in the Commonwealth after graduation and become legal residents of Massachusetts may apply for a refund of all or part of the tuition paid in excess of the rates charged Massachusetts residents.

e. The residence of a wife shall follow that of the husband.

f. The prescribed form of application for classification as to residence shall be executed for each student. Misrepresentation of facts to evade payment of the proper rate of tuition shall constitute sufficient cause for suspension or permanent separation from the Institute.

g. Payment of one-half of the total yearly tuition will be made during the registration for each semester.

h. The President of the Institute is authorized to adjust individual cases within the spirit of these rules.

Note: Wherever mentioned above, the word *residence* is considered to mean *legal domicile.*

ROTC Deposit $25

This deposit covers loss of, or damage to, uniform or equipment used for ROTC instruction. Required of all students enrolled in ROTC. The entire amount, less charges, will be refunded upon the completion of the ROTC requirements. If, at any time, the charges against a student exceed the amount on deposit, the student will be required to pay such charges and to make an additional deposit of $25.

Activity and Insurance $40

Each student will pay $20 each semester of the academic year as a student activity and insurance fee. The payment of this fee entitles the student to free admission to all athletic events, a mailbox in the campus post office, a subscription to the student newspaper, and a copy of the yearbook. A portion of this fee helps to support the general student activities under the jurisdiction of the Student Council. It pays for the compulsory accident insurance policy which covers each student against accidents during the academic year and also contains a compulsory bonding fee which protects the Institute against unpaid student charges.

Residence Halls $275

All students, except those who live in Lowell or the surrounding community, may be required to live in one of the residence halls (see page 23 for details). The double rooms rent for $275 per student per year. One-half of the rent ($137.50) is payable at the start of each semester.

Laboratory and Materials Fee

To cover the cost of materials and normal breakage in all laboratories, each student will be charged as follows:

All freshmen	$12/semester
Upperclassmen enrolled in:	
(a) Textile Manufacturing, Textile Engineering, Textile Sales, or Electronic Engineering	$12/semester
(b) Paper, Leather, or Plastics Engineering	$17/semester
(c) Textile Chemistry	$22/semester

The above charges are not refundable. Excess breakage will be billed direct to the student. These fees are payable each semester regardless of the number of laboratories taken and represent an average flat charge per semester for the regular four-year program in each of the above courses.

The above fee must be paid before a student can be admitted to laboratory work.

COMMENCEMENT FEE $15

Covers commencement expenses such as degree and case, rental of cap and gown, invitations, printing and other incidentals.

LATE REGISTRATION FEE $5

Any student who does not complete his registration (including the payment of all fees) by the close of the registration period stated in the Institute calendar may be required to pay an additional fee of $5.00.

OFFICIAL TRANSCRIPT FEE $1/copy

Each student will be allowed free of charge a total of three transcripts of his scholastic record. A charge of $1.00 per copy will be made for each *additional* transcript.

AUDITING FEE . . . . $5/credit hour

All students regularly enrolled and paying the full tuition charge in any semester may audit courses in that semester without charge providing proper approval is obtained.

Students not regularly enrolled or not paying the full tuition charge for the semester must pay $5 per credit hour to audit a course and must obtain proper approval.

BOOKS AND MATERIALS—Students must provide their own books, stationery, tools, etc., and pay for any breakage or damage that they cause to machines, laboratory equipment, and other property of Lowell Technological Institute.

All raw stock and yarn furnished to the students, and all the productions of the Institute, remain or become its property, except by special arrangement, but each student is allowed to retain specimens of yarn or fabrics that he has produced, if mounted and tabulated in accordance with the requirements of the department. It is understood that the departments may retain such specimens of students' work as they may determine.

No books, instruments, or other property of the Institute loaned to the students are to be removed from the premises except by special permission.

REFUND SCHEDULE—Applications for refunds, filed with the Bursar on withdrawal, will be made in accordance with the following table:

No. of Weeks		*Refund*
At least	*But less than*	*Rate*
0	2	80%
2	3	60%
3	4	40%
4	5	20%
5 and over		None

Summary of Expenses Per Year

Tuition (residents of Massachusetts)	$150
Tuition (residents of other states)	250
Tuition (residents of other countries)	500
Dormitory rate per year	275
Laboratory and Materials Fee	
(a) All freshmen	24
(b) Upperclassmen enrolled in:	
Textile Manufacturing, Textile Engineering, Textile Sales, or Electronic Engineering	24
Paper, Leather, or Plastics Engineering	34
Textile Chemistry	44
Student Activity and Insurance Fee	40
ROTC Deposit	25
*Books and supplies	50
Commencement Fee	15
Late Registration Fee	5
Official Transcript Fee	1

*Books and supplies for the first year cost about $80, second and third year $35, and fourth year $50, thus averaging about $50 per year for the four years.

STUDENT ACTIVITIES

Lowell Technological Institute believes that sound educational practice seeks to develop the whole personality of the student. Accordingly, Faculty and Administration encourage extra-curricular activities and support the development of a varied and well-rounded program of activities to supplement the purely academic phase of undergraduate life. This program provides opportunity for participation in formal and informal sports, in class and campus self-government, and in the many clubs and special interest activities which appeal to the varied interests of the student body.

Student Council

The Student Council is the chief body for the conduct of self-government in student affairs. It is composed of four officers elected at large by the student body, the president of each undergraduate class, and one representative from each of the classes.

By virtue of its function as chief governing body for student affairs, it exercises administrative control over all campus organizations formed under its supervision; represents the student body in matters requiring conference with the Administration and Faculty; investigates grievances submitted by students or student groups; sponsors all-campus dances, banquets, and other social affairs; and supervises the expenditure of the unallocated portion of the Student Activity Fee. It functions in accordance with the specific prescriptions of its Constitution and By-Laws.

Arnold Air Society

The Air Force Association sponsors this military fraternity at all colleges that have an AFROTC program. The purpose of the Arnold Air Society is to unite selected Advanced AFROTC Cadets by a fraternal bond in support of a common cause—the Air Age. A chapter of this society has been established at this Institute. The Arnold Air Society is responsible for a cadet sports program and a variety of social affairs during the academic year, culminating in a military week end which features a colorful drill ceremony and has as its climax the formal Military Ball. One of the outstanding events of the Military Ball is the naming of the Honorary Cadet Officers.

Athletics

The Athletic Association promotes an extensive varsity and intramural sports program. All students are members of the Ath-

letic Association and receive free admission to all intercollegiate contests played at home.

Soccer, Basketball and Baseball are varsity sports at the Institute. Competition is chiefly with teams in the northeast portion of the country. Lacrosse, Golf, Tennis and Ski Teams also compete regularly with other colleges in the area.

Intramural sports are sponsored by the Director of Intramural Athletics with an interesting year-long program of both league and informal competition between the classes, residence halls and fraternities.

Band

The AFROTC Band is composed primarily of cadets who are musicians or who desire to learn to play a band instrument. In addition to providing the music for the AFROTC ceremonies, the band adds considerably to the color and life of the campus by participating in various Institute and civic programs.

Circle K

The Circle K club is the student chapter of the Kiwanis at the Institute. In addition to performing many services in the public interest, they assist the administration of the Institute in running the freshman orientation program each year.

Flying Club

Membership in the club is open to all students. The club maintains an airplane for the use of the members. Flying lessons may be taken, and all AFROTC members who solo will be awarded AFROTC wings.

Fraternities

The Interfraternity Council fosters the common interests of the four fraternity chapters at the Institute. This organization sponsors joint social and athletic contests among the fraternities.

The four fraternities have their own houses for fraternity socials and meetings, providing centers for the social life off the campus. The fraternities are: Delta Kappa Phi, Omicron Pi, Phi Psi, and Pi Lambda Phi.

Glee Clubs

Membership in the Men's and Women's Glee Clubs is open to any student who wishes to improve his vocal ability and share with fellow students the satisfaction of producing fine music. Although these Glee Clubs are relatively new to the L.T.I. scene, both are

active and growing organizations with professional direction supplied by the Institute.

International Students Circle

This club lists all foreign students at the Institute as its members. It serves to bring into close contact all these students who may have some difficulty in becoming adjusted to a new language or way of living. These students are in demand by local civic groups to serve as speakers on many programs.

The Nucleus

The club was initiated to serve as a focal point for students to meet and present ideas and reports regarding actual activities in industry. The club has a membership limit of 15 members who are the leaders of all the major activities on the campus. A high scholastic rating is also a prime requisite for active participation.

"Pickout"

The "Pickout" is the annual year book of the campus. Those who serve on the staff secure a valuable training in the editorial, art, and business problems involved in the production of a top-quality photo-literary history of the academic year.

Professional Societies

The following societies conduct monthly meetings at which students and outstanding speakers present technical papers and lectures. Frequent field trips to industrial plants are also made by the members. These societies include:

(1) American Association of Textile Chemists and Colorists
(2) American Society of Mechanical Engineers, Student Chapter
(3) Engineering Society
(4) Leather Engineering Society
(5) Paper Engineering Society

Radio Station

The Radio Station (WLTI) is an all-student enterprise built and maintained by members of the Lowell Technological Institute Broadcasting Society. Programs are transmitted by a carrier current to the buildings of the campus from the station studio.

The radio station sells air time to local merchants and thus is a self-supporting organization. It provides a fine opportunity for

students to learn business practices as well as broadcasting and radio techniques.

Religious Groups

Hillel. The Hillel Counsellorship was established to provide social, cultural and religious programs for the Jewish students at the Institute. Discussion groups are held weekly and brunches or dances monthly. Speakers are invited to talk on subjects of interest to the whole student body. Hillel groups, located at most of the larger colleges and universities, are sponsored by the national B'nai B'rith organization.

Iona Student Fellowship. A group composed of students and faculty members of various races and creeds who, by uniting in a common fellowship, attempt to understand the will of God through worship, study and action, and thus realize it both in personal living and in working toward a better society.

Newman Club. The Newman Club is an organization sponsored by the Catholic students at the Institute. It conducts programs of a social and religious nature.

Rifle Team

The AFROTC Rifle Team is a member of the National Rifle Association and the New England College Rifle League. In addition to competing in a full schedule of intercollegiate rifle matches, the team competes each year against all the AFROTC units in the First Air Force for the FIRST AIR FORCE TROPHY and all the AFROTC units in the nation for the WILLIAM RANDOLPH HEARST TROPHY.

Scholastic Honor Society

Membership in Tau Epsilon Sigma is open to members of the Junior and Senior Classes who are elected on the basis of outstanding scholastic achievement and character.

Sorority

The Sorority Phi Sigma Rho provides a center for the social life and association of the young women enrolled in the various programs of the Institute.

T.O.C.

The Tech Orientation Committee has as its special function the introduction of the new student to college life. During Orien-

tation Week, the first week of school for the freshmen, a series of activities is planned by T.O.C. to enable freshman class members to meet each other and to realize their responsibilities to their college.

Tech Players

All the theatrical activities of the Institute are centered around the Tech Players. For years the annual production of this group has been a high point in the social calendar.

"The Text"

"The Text" is the campus newspaper. Prepared and edited by the students, this bi-weekly publication offers excellent journalistic and business experience to those who work on its staff.

Varsity Club

This club is composed of students who have earned letters in any of the six intercollegiate sports, namely, Baseball, Basketball, Golf, Lacrosse, Soccer and Tennis. Its purpose is to help athletes academically and to foster a lasting friendship among the men participating in athletics.

FINANCIAL AID TO STUDENTS

SCHOLARSHIPS

A large number of scholarships are available to students and prospective students of Lowell Technological Institute through funds contributed by various trusts, organizations, civic bodies and industrial firms. Many of the scholarships are renewable yearly for the balance of the student's undergraduate program, providing a satisfactory scholastic average is maintained; others are only for a specified period of time.

All entering freshmen who are candidates for scholarships should make direct application to the College Entrance Examination Board, P. O. Box 592, Princeton, New Jersey, with a request to take the Scholastic Aptitude Test, and also make application to the Dean of Students, Lowell Technological Institute, Lowell, Mass.

Available for Freshmen and Upperclassmen

1. Alumni Association Scholarships—Lowell Technological Institute

Scholarship funds under the care of the Alumni Association make available several scholarships a year which cover tuition and miscellaneous fees. These scholarships are renewable if a satisfactory scholastic standing is maintained.

2. Berkshire Fine Spinning Associates, Inc. Scholarship

A number of scholarships covering tuition and living expenses for four years are offered in Textile Engineering and Manufacturing by the Berkshire Fine Spinning Associates, Inc., Providence, Rhode Island. Eligible applicants are:

a. Male employees of Berkshire Fine Spinning Associates, Inc. who have had adequate secondary school training.

b. High School graduates who are sons of present employees.

Interested students should contact the Berkshire Fine Spinning Associates, Inc., 704 Hospital Trust Building, Providence 1, Rhode Island.

3. Russell L. Brown Scholarship—donated by Davis and Furber Machine Company

This scholarship is open to a student acceptable to Lowell Technological Institute who plans to enroll in the curriculum of Textile Engineering or Textile Manufacturing. Preference is given

to employees and sons or grandsons of employees of Davis and Furber Machine Company. The selection is based on general scholarship, initiative, and need. The stipend is $300. The appointments are for one year only but are renewable.

4. Caron Spinning Company Scholarship

This scholarship is awarded to employees or to relatives of employees of the Caron Spinning Company and to graduates of Rochelle, Illinois High School, on the basis of general scholarship, initiative, and character. The amount of the scholarship is $1,250 each year, and it is awarded on a four-year basis provided satisfactory academic standing is maintained. Application should be made directly to Caron Spinning Company, Rochelle, Illinois.

5. A. C. Lawrence Leather Company Scholarship

The A. C. Lawrence Leather Company in Peabody, Massachusetts makes available a $500 scholarship on a one-year basis to a student in Leather Engineering at Lowell Technological Institute. Preference is given to an employee or member of an employee's family, or to a resident in a town in which the Company operates. If no eligible applicants are available, the award will be open to any member of the Leather Engineering Department on the basis of merit.

6. Leather Engineering Department Scholarships

The Leather Engineering Department has funds for several scholarships and awards under its jurisdiction which it periodically releases for scholastic aid purposes through the Institute Scholarship Committee. These funds have been made available by interested industrial firms and trade organizations. These scholarships are available to deserving students enrolled in the Leather Engineering course who need financial assistance for scholastic purposes.

7. City of Lowell Scholarships

The City of Lowell has appropriated funds to provide a total of five scholarships every two-year period. These scholarships are awarded on the basis of competitive examinations to residents of the City of Lowell, Massachusetts, who are enrolled in the freshman class at the Institute. The amount of the scholarship is $150, which is full tuition at the Institute, and it is renewable provided satisfactory scholastic grades are maintained.

8. Commonwealth of Massachusetts Scholarships

Ten scholarships of $250 each year are available for young men and women who are residents of the Commonwealth of Massachusetts and are enrolled in the freshman class at the Institute.

Awards are made on the basis of competitive examinations and the scholarships are renewable provided satisfactory grades are maintained.

9. The McLaurin-Jones Company Scholarship

This scholarship is awarded annually to a member of the Brookfield or Ware High School graduating class or to an employee of the McLaurin-Jones Company for work in the Paper Engineering Department. The scholarship for $500 is renewable from year to year for four years if a satisfactory scholastic record is maintained.

10. Mohawk Carpet Mills Textile Scholarship

A $2,000 scholarship has been made available to high school graduates or employees of the Mohawk Carpet Mills who are residents of New York State. All applicants must have applied for enrollment in one of the various textile courses at the Institute in order to be eligible. Application must be made to the Mohawk Carpet Mills, Inc., Amsterdam, New York.

11. New England Tanners Club Scholarship

This scholarship is awarded by annual vote of the New England Tanners Club and is granted to a student in Leather Engineering at Lowell Technological Institute. Preference is given to employees of the member companies of the New England Tanners Club or to their families. If no eligible applicants are available, awards will be open to others on the basis of secondary-school scholastic performance and evidence of potential leadership. The amount of the scholarship is $1,000, awarded on a one-year basis.

12. New England Textile Foundation Undergraduate Scholarships

Scholarships of $250 per year plus tuition are available by means of competitive examinations to students who qualify for entrance to Lowell Technological Institute under the terms described in the ADMISSION OF UNDERGRADUATES section of this Bulletin. These scholarships are for one year but are renewable provided a satisfactory scholastic standing is maintained. All students interested in competing for one of these awards should make application directly to the New England Textile Foundation, 31 Canal Street, Providence, Rhode Island no later than January 15. Detailed instructions and the necessary application forms will be sent to each applicant accepted for the competition.

13. Pacific Mills Worsted Division Overseers Association Scholarships

Several $150 scholarships for freshmen only are supported by the Overseers Association of the Pacific Mills Worsted Division,

Lawrence, Massachusetts. The Overseers Association selects qualified candidates, who must then meet with the approval of the Institute.

14. Dr. Geoffrey R. Broughton Paper Engineering Scholarship

A scholarship prize of $100 is awarded at the beginning of the spring semester to the member of the freshman class who achieves the highest scholastic standing. The prize is made available by a number of interested companies for students enrolled in the Paper Engineering Department.

15. Sylvan I. Stroock Scholarship—S. Stroock & Co., Inc.

Awards are made on the basis of scholarship, financial need, leadership, and promise of success in textile fields. The sum available for scholarship purposes is $500 per year, offered annually at the discretion of the Scholarship Committee.

16. H. Webster Thomas Memorial Scholarship—donated by the Rohm and Haas Corporation of Philadelphia, Pennsylvania

This scholarship is awarded for a four-year period to a student in Leather Engineering at Lowell Technological Institute. The amount of the scholarship is $500 per year.

17. United Elastic Corporation Scholarships

Scholarships in the amount of $250 are available through the United Elastic Corporation, Easthampton, Massachusetts.

These scholarships have been established primarily for employees of the United Elastic Corporation, or members of their families. Other residents of the communities where plants are located, however, may enter applications for consideration. Preference is given to native New Englanders and to those who agree to work summers in approved mills.

Qualifications for scholarships include good character and standing in the community, aptitude for technical training, and ability to pass entrance requirements of Lowell Technological Institute. With the approval of the United Elastic Corporation and the Lowell Technological Institute, scholarships may be awarded to deserving upperclassmen.

Each scholarship is for a one-year period and further extension if the performance of the student during the year is satisfactory. The United Elastic Corporation will, so far as possible, furnish suitable employment to the student during the summer vacation period and following graduation.

All applications should be made through the plant nearest to the residence of the applicant. Plants are located at Easthampton, Lowell, and Littleton, Massachusetts; West Haven, Connecticut; and Stuart, Virginia.

18. Jacob Ziskind Memorial Scholarship

This scholarship was established by the employees of the Merrimack Manufacturing Company in memory of Jacob Ziskind.

Qualifications for the scholarship include good character, scholastic record, initiative and ability to pass the entrance requirements at Lowell Technological Institute. Preference in granting the scholarship is given to employees of the Merrimack Manufacturing Company or members of their immediate families residing in the Greater-Lowell area. However, other residents of Greater-Lowell may enter applications for consideration.

The Merrimack Manufacturing Company will, in so far as possible, provide suitable on-the-job training during the summer vacation period and following graduation. The scholarship provides tuition, books, supplies and such deposits as are required to enroll the student in the course selected. The scholarship is renewable provided a satisfactory scholastic record is maintained.

Available for Upperclassmen Only

1. Arthur Besse Memorial Scholarship

The scholarship is awarded by the Arthur Besse Memorial Trust to a student majoring in Woolen and Worsted Manufacturing and planning to continue in that industry after graduation. Awards are based on need, scholarship, and qualities of character and leadership. The amount of the scholarship is $500 a year, and is renewable if a satisfactory scholastic record is maintained.

2. Boston Paper Trade Association Scholarship

This scholarship is open to any sophomore, junior, or senior enrolled in the Paper Engineering Department who is a resident of New England. It is awarded on the basis of scholarship and general character. The amount of the scholarship is $150. It is anticipated that the scholarship will be made renewable each year by the Association.

3. Fiberglas Scholarship—Owens-Corning Fiberglas Corporation

This scholarship is awarded annually to an outstanding sophomore in any of the textile courses. It pays the recipient full tuition and $500 per academic year for each of the junior and senior years. Selection is based upon academic record, character, qualities of leadership, and need.

4. The Gehring Foundation Memorial Scholarships—in memory of Henry G. Gehring and his son, Edward H. Gehring, both of whom were engaged in the Lace Industry.

These scholarships are made possible as a result of the Gehring Memorial Foundation of New York. Selection of recipients made by the Scholarship Committee may be reviewed by the Gehring Foundation. The amount of the scholarship is $75 per semester and is renewable if a satisfactory scholastic record is maintained.

5. Ralph E. Hale Scholarship

This scholarship was established by the Northern New England Section of the American Association of Textile Chemists and Colorists in memory of Ralph E. Hale, 1951 Chairman-elect of the Section and a 1931 graduate of L.T.I. This scholarship is awarded annually to a student at the completion of the junior year in the course in Textile Chemistry. The amount of the scholarship is $250 per year.

6. Interchemical Corporation Scholarship

A one-year scholarship worth $500 has been made available by the Interchemical Corporation of Pawtucket, Rhode Island. The scholarship was established for award to a member of the junior class majoring in chemistry and is awarded on the basis of scholastic achievement, character, and leadership potential.

7. New England Paper Merchants Association Scholarships

Two scholarships are open to any sophomores, juniors or seniors in the Paper Engineering Department who are residents of New England. They are awarded on the basis of scholarship and general character. The amount of each is $150. It is anticipated that they will be made renewable each year by the Association.

8. Dr. Geoffrey R. Broughton Paper Engineering Scholarships

Three prizes of $100 each are awarded at the beginning of each fall semester to the top ranking students enrolled in each of the sophomore, junior and senior classes of Paper Engineering.

Three prizes of $100 each are awarded at the beginning of each spring semester on the same basis. These prizes were made available by a number of interested companies for students enrolled in the Paper Engineering Department.

LOAN FUND

A loan fund is available for the purpose of assisting upperclassmen to continue their education at Lowell Technological Institute. Students may make application for a loan through the Faculty Treasurer of the Lowell Textile Associates, Incorporated.

Repayments on any loan which are made while the student is still in school are interest free. Loans repaid after the student

leaves school (for whatever reason) bear 4% interest beginning three months after the date at which the student officially leaves school. Repayments are not required until the student separates from Lowell Technological Institute, at which time repayments are due quarterly at a rate of $10.00 per quarter the first year and $20.00 per quarter each year thereafter until the loan is repaid. Additional payments may be made at any time so as to reduce indebtedness at a more rapid rate.

FELLOWSHIPS

There are a number of fellowships which are available to students pursuing graduate studies. These fellowships include:

1. Celanese Corporation of America Fellowship

This fellowship is available for persons accepted for graduate study at the Institute in the fields of textile chemistry and textile engineering. To qualify, the applicant must have a Bachelor of Science degree outside the field of textiles and must be a U. S. citizen. The fellowship pays $1500 per year plus tuition and fees. Application should be made to the Director of the Graduate School at Lowell Technological Institute.

2. Coats and Clark Inc. Fellowship

This fellowship is available only to graduates of textile colleges. The fellowship is made available for graduate work at the Massachusetts Institute of Technology and pays approximately $700 per year plus tuition. Application should be made directly to M.I.T.

THE AIR FORCE ROTC UNIT

An Air Force Reserve Officers Training Corps unit was established at the Lowell Technological Institute on July 1, 1951. Instruction began with the opening of the first semester of the academic year 1951-52.

By vote of the Board of Trustees, all able-bodied male students enrolling in Lowell Technological Institute for the first time on or after September 13, 1951 must satisfactorily complete the basic ROTC work (freshman and sophomore years) before receiving a Bachelor of Science degree. The President of the Institute may waive this requirement and permit the substitution of an equivalent amount of work only for those individuals who are not liable to military service under existing laws and regulations (for example, not a citizen of the United States, previous military service, etc.).

Uniforms and all equipment and textbooks required for the ROTC work will be supplied by the United States Air Force. Students in the Advanced Course will receive the standard cash payment allowed by the Air Force in lieu of subsistence.

Mission

The mission of the AFROTC unit is to develop in each cadet those attributes essential to his progressive advancement to a commission as a Second Lieutenant in the United States Air Force Reserve and further, to prepare him to fill positions of increasing responsibility as a commissioned officer in such duties in the Air Force as may be required by the national defense effort.

The AFROTC program takes into consideration the fact that many of the academic subjects in which Institute students are enrolled have as much direct relationship to military duties as they have to a civilian career. The courses contained in the AFROTC curriculum have been carefully selected to augment those academic subjects. The purpose of this course of instruction, then, is to enhance the otherwise high qualifications of the student with a thorough Air Force background.

Basic Course

The work covered in the first two years is considered the Basic Course. In addition to exercises in Leadership and Drill, this work includes classroom instruction in the Airplane and the Air Age, and the Elements and Potentials of Air Power. As stated above, the satisfactory completion of the Basic Course is a requirement for the Bachelor of Science degree in all courses offered at the Institute. Cadets who satisfactorily complete the Basic Course

may apply for the Advanced Course subject to approval by the Selection Board. This normally leads, upon graduation, to a commission as a Second Lieutenant in the Air Force Reserve.

Advanced Course

The Advanced Course, consisting of the last two years of Air Force ROTC instruction supplemented by a summer camp, is designed to develop in the student to the highest degree possible those understandings, attitudes, skills and attributes of leadership considered essential in the development of all Air Force commissioned officers.

Air Science III, taught during the student's junior year, analyzes such problems as command and staff concepts; leadership laboratory; problem-solving techniques; communications process; principles and techniques of learning and teaching; Air Force correspondence and publications; military law and courts, and boards; applied air science, including aerial navigation, weather, and functions of the Air Force Base.

Air Science IV, taught during the student's senior year, contains a review of the previous years of air science; a critique of the Summer Camp training; leadership and management; military aspects of world political geography; principles of management; military aviation and the art of war; career guidance; and briefing for commissioned service.

Summer Camp

In addition to completing satisfactorily the subjects required in the above generalized curriculum, each cadet enrolled in the Advanced Course is required to supplement his training by attending a summer camp of approximately four weeks duration. Usually this camp is attended during the summer preceding his senior year. Transportation from the legal residence of the cadet to the camp and return, uniforms, food, lodging, and medical and dental care are provided by the Air Force and, in addition, the cadet receives the pay of a basic Airman.

Field Trips

Periodically, the Department of Air Science and Tactics conducts field trips to various Air Force installations for the purpose of orientation. They frequently include range firing and conducted tours of the base. Sometimes a familiarization flight is added. Efforts are made also to assist those cadets who are interested in flying to gain as much information as possible about the operational phase of the Air Force.

Contributions to Student Life

In addition to the military and academic phases of its program, the Department of Air Science and Tactics sponsors various extra-

curricular activities which are designed to produce a well-rounded cadet. Much of this activity is undertaken by the Arnold Air Society.

Cadet Decorations and Awards

A number of medals are awarded to selected cadets and cadet officers at a special Parade and Review held each spring.

Air Force Association Medal—Normally awarded to the outstanding cadet of the senior class on the basis of his military record for the entire four years of the ROTC program.

Alumni Association Medal—Awarded to the most outstanding cadet, regardless of class, for exemplary achievements in academic, military, and extra-curricular activities. This medal is given by the Lowell Technological Institute Alumni Association.

Distinguished Commander Medal—Awarded to a cadet holding the rank of Major or higher for outstanding performance.

Distinguished Squadron Commander Medal—Awarded to a cadet holding the rank of Captain or higher for outstanding performance in leadership and drill.

Distinguished Flight Leader Medals—Awarded to two cadet lieutenants for outstanding performance in leadership and drill.

Distinguished Non-Commissioned Officer Medals—Awarded to the three cadet non-commissioned officers who have distinguished themselves by their excellence in leadership and drill.

Distinguished Cadet Medals—Awarded to the three cadets of the second-year Basic Course who have distinguished themselves through their work in leadership and drill.

In addition to the above medals all cadets are eligible to compete for the following:

Arnold Air Society Scholarship—A scholarship of $100 is awarded periodically to a selected member of one of the Arnold Air Society Squadrons in the First District. The basis for selection is the financial need of the cadet coupled with his academic and military record.

Distinguished Military Graduate—Each year certain AFROTC graduates are selected to receive this honor. The bases of selection are:

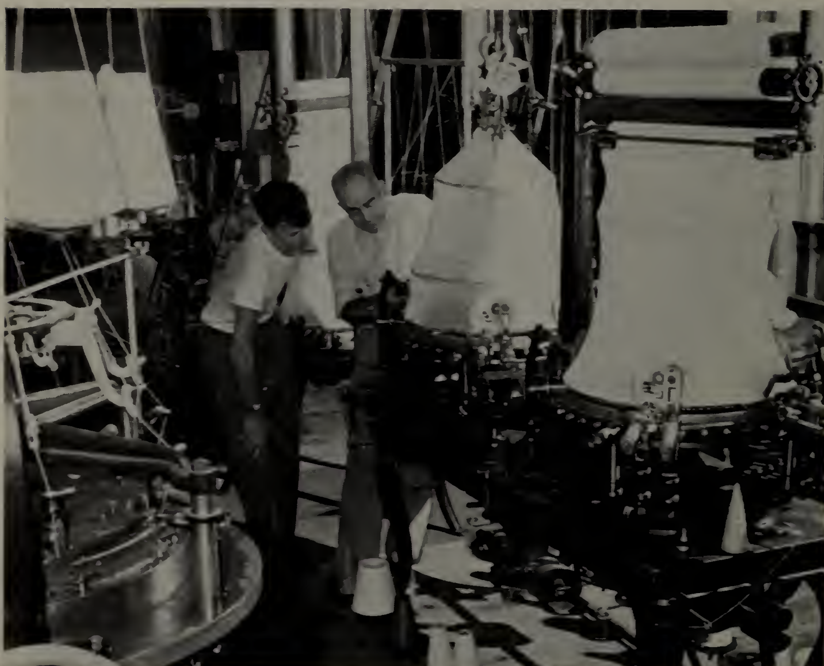
(a) Qualities of military leadership.
(b) High moral character.
(c) Aptitude for military service.
(d) Excellence in academic standing and/or outstanding leadership in campus activities.

A Distinguished Military Graduate may be offered a commission as a second lieutenant in the United States Air Force.

At Work in the Library

Relaxing in Student Lounge

Surveying New Textile Equipment



In Knitting Laboratory


Freshman Chemists at Work


In Paper Engineering Laboratory

Student Room

Auditorium, Cumnock Hall

Student in Electronics Laboratory

In Leather Engineering Laboratory

Soccer

Southwick Hall

PLACEMENT

Industrial Training Program

The Placement Bureau with the assistance of Industry endeavors to place every qualified underclassman during the summer vacation periods in an industrial position similar to the student's major field of interest at the Institute. These training opportunities are available in chemistry, electronics, leather, paper, and textiles, and are open to all students who have completed their sophomore year except those on scholastic or disciplinary probation.

The objectives of the undergraduate Industrial Training Program are:

(1) To help supply essential industrial experience to the undergraduate;

(2) To provide experience in human engineering only obtained in Industry;

(3) To furnish an employment pool enabling industry to preview individual students;

(4) To further the liaison between the Institute and Industry.

Placement Service

The Placement Bureau maintains active contacts with a number of industrial firms throughout the country in each of the fields of engineering presented at the Institute. A complete file of opportunities and data on various industries and companies is available to the members of the graduating class in the Placement Office.

The Placement Bureau arranges for the visits of representatives from industrial firms to interview students. A series of industrial seminars is conducted in which industrial speakers outline opportunities in particular industries and the various positions within the companies.

In addition to assisting in the placement of graduating students, it also assists industry in the difficult job of locating trained and experienced personnel. The office also assists Alumni to establish new connections.

The Placement Office, of course, cannot give any graduate a guarantee of employment; however, during the past year the Placement Bureau listed several jobs for every graduate and practically all seniors were placed before Commencement.

COOPERATIVE PLAN

Massachusetts Institute of Technology—Lowell Technological Institute

A cooperative arrangement between Lowell Technological Institute and Massachusetts Institute of Technology includes the following major provisions:

(1) The mutual use of the manufacturing and research facilities for graduate and undergraduate theses;

(2) The mutual use of textile libraries of both institutions;

(3) The opportunity for students at each institute to supplement their work by taking work presented at the other institute, and summer programs of instruction;

(4) The formation of joint seminars and the interchange of staff members for special lectures;

(5) Frequent student visits and joint meetings of student societies.

SPECIAL SERVICES OF L.T.I. TO INDUSTRY AND THE COMMUNITY

In addition to the services rendered by the Evening Division, the Alumni Memorial Library, the Research Foundation, and the Summer School program, the college provides such special services to industry and to the community as the following:

Industrial seminars, conferences, and radio programs;

Guidance work in the high schools;

Consultive opportunities with the Faculty;

Collaboration with the Foreign Operations Administration of the Government by showing foreign visitors facilities and by counsel:

Special radio and television programs;

Participation in state-wide and nation-wide exhibits and programs and in community projects.

For information relative to these programs, address The Coordinator of Special Services, Lowell Technological Institute, 1 Textile Avenue, Lowell, Massachusetts.

SUMMER SESSION

The Summer Session is designed primarily to serve three principal areas of interest: Professional Advancement Courses for industrial personnel and home economists; Undergraduate Credit Courses for college students with course deficiencies; and Pre-College Refresher Courses for incoming freshmen at L.T.I.

The industry-sponsored professional advancement program comprises a series of specialized, intensive, one- to three-week courses in textile, paper, and leather technology. The six-week undergraduate credit program stresses fundamental courses in college mathematics, physics, chemistry, English, and economics. The pre-college refresher program is especially designed to articulate the high school training of prospective L.T.I. students with the more intensive college-level studies in basic mathematics, physics, chemistry, and English. The non-credit refresher courses are offered both in a six-week and a four-week session in order to provide adequate coverage for a number of minor deficiencies in the high school background.

For further information on the Summer Session, write to Professor Ernest P. James, Director of Summer School.

EVENING DIVISION

The Evening Division offers a wide variety of courses in engineering, chemistry, textiles, paper, leather, electronics, plastics, the social sciences, and art. These courses are designed to fit the needs of the community, particularly those people engaged in industry who wish to further their education.

Some of these courses carry graduate school credit and others undergraduate college credit. A substantial number of non-credit courses are also offered to the general public.

The Evening Division does not grant degrees but credits may be transferred to the regular day school towards either the B.S. or M.S. degree.

Two semesters of 15 weeks each are offered, starting early in October and early in February. For further information concerning the Evening Division, write to Professor Charles L. Daley, Director of the Evening Division.

THE GRADUATE SCHOOL

By act of the General Court of 1935, authority was given to Lowell Technological Institute to confer degrees of Master of Science in Textile Chemistry, Master of Science in Textile Engineering, and Master of Science in Textile Manufacturing to graduate students who satisfactorily complete a program of advanced standing. Recently, authority has been granted to include Master of Science work in Paper Engineering, Electronic Engineering, and Leather Engineering which will lead to corresponding degrees.

The graduate programs of study offered by the Institute provide for advanced specialized training required by technologists who contribute to industrial progress and human welfare through the application of scientific and engineering principles to existing industrial and human problems. The courses of study allow the graduate of the Institute or of other colleges training men in textile, paper, or leather technology to broaden his knowledge and skills in these areas and to develop a sound research approach to problems of the basic sciences, the development of new products, and industrial production.

Inquiries concerning graduate studies should be addressed to the Director of the Graduate School.

I. Admission to the Graduate School

A. *General Admission*

To be eligible for admission to the Graduate School, an applicant must have received a Bachelor's degree in an acceptable four-year course in which he has maintained a uniformly high scholastic rating. Both quality and quantity of the previous training will be considered. Selection of those applicants admitted will be based as far as possible on their ability to pursue graduate work of high quality.

B. *Special Student Status*

An applicant who meets the general admission requirements, but who wishes to concentrate on certain subjects in specialized techniques, or in some cases on special research programs, may request to be considered for Special Student Status. This work would not lead to a degree.

Acceptance as a special student is contingent upon the consent of the instructor in charge of each subject to which admission is desired.

C. *As a Provisional Graduate Student*

An applicant for admission to the Graduate School who is unable to meet all the requirements specified in (A) may be accepted provisionally, if he satisfies the department in which he wishes to enroll that he is probably able to pursue graduate studies successfully.

The status of such a student will be changed to that of a graduate student upon demonstration of his ability to pursue graduate studies successfully as measured by the completion of his first academic year's work with an average rating of at least 2.5 (80%).

D. *Application Procedure*

Those wishing to carry on graduate studies at this Institute should file application with the Director of the Graduate School. Applications may be obtained from the Office of the Graduate School.

Applications for admission should be complete and accurate and must be received not later than the first of June preceding the fall term in which the applicant wishes to enroll. Applications must be supported by letters from at least two persons qualified to judge the ability of the applicant to carry on graduate work and research. The letters should be sent directly from these persons to the Graduate School.

Transcripts of all undergraduate records (and graduate, if any) must be sent directly to the Office of the Graduate School by the institutions which the applicant has previously attended. All transcripts must be official, with appropriate seals and signatures. Records, descriptions of subjects, and letters must be in English. Each subject must be described in terms of content, scope, number of hours per week, and number of weeks duration. Lecture and laboratory time should be properly distinguished. If a catalogue giving such descriptions in English is available, the subjects taken may be clearly marked in a copy sent to the Graduate School.

A reading and speaking knowledge of English is necessary for an applicant to be considered for acceptance. Most of the subjects are presented in lecture form, making it difficult for those who do not have a reasonably fluent command of the English language.

Except in unusual circumstances, applications will be acted upon and the applicant notified of the decision by July 1. Foreign applicants are urged to make application as early as possible so as to leave enough time for visa and other arrangements to be made.

II. Graduate Courses Offered

Graduate programs are offered in the fields of textile chemistry, textile engineering and paper engineering.

Because of the varied objectives of the graduate student, the course of study is arrived at through consultation with the student's graduate adviser.

Subjects numbered 500 and above are offered for graduate credit. A limited number of undergraduate subjects are available for graduate credit. The choice of these undergraduate subjects with graduate credit is subject to the approval of the Department Head.

Each program will include an original thesis.

TEXTILE CHEMISTRY

Graduate work in Textile Chemistry allows qualified students the opportunity to pursue advanced study in the physical chemistry of textile processing such as dyeing, wet finishing and fiber modification. Studies on the organic chemistry of dyes may also be undertaken.

Recent studies have been on the theories of dyeing of natural and synthetic fibers and the application of synthetic finishes.

Such studies are carried out by graduate class work, seminars, and original theses.

The following subjects must be included in the student's program:

First Semester:

CH 503 Interpretation of Data
CH 505 Physical Chemistry of Dyeing
CH 531 Textile Chemistry Seminar

Second Semester:

CH 512 Physical Chemistry of Surface-Active Agents
CH 516 Chemical Thermodynamics
CH 532 Textile Chemistry Seminar

Other subjects of his own selection are to be added to give a suitable program.

TEXTILE ENGINEERING

Graduate work in Textile Engineering is offered so that qualified students who have completed one of the courses in Textile Engineering at Lowell Technological Institute may undertake advanced studies concerning the physical properties of textile materials and modern methods of evaluating them.

Opportunity is also provided for engineering graduates of other colleges to secure fundamental knowledge of textile materials

and processing which is a co-requisite for graduate study and research in Textile Engineering.

For graduate subjects in Textile Engineering consult subject descriptions under Engineering, Mathematics, and Physics.

PAPER ENGINEERING

The graduate program in Paper Engineering is for the purpose of giving advanced work in papermaking, paper converting or allied fields.

The Paper Engineering Department will consider graduate students from three different sources:

(a) Graduates of the Lowell Technological Institute B.S. Paper Engineering course.

(b) Paper Engineering B.S. and M.S. graduates of other schools.

(c) General B.S. and M.S. Engineering graduates with no previous paper training.

Students with the backgrounds given under (a) and (b) should be able to complete the work in one academic year. Students in group (c) should be able to complete the degree requirements in two academic years.

A graduate student in Paper Engineering will take approximately 50% of his graduate subjects (including thesis) in the Paper Engineering Department. The balance may be taken as electives related to the paper field and approved by the Department.

The graduate subjects offered in this Department are:

PA 501-502	Graduate Thesis
PA 503-504	Advanced Paper Microscopy
PA 505-506	Advanced Papermaking and Paper Converting

III. Term of Residence

Applicants with a sufficient background in their chosen field of concentration will normally require one academic year of residence to complete the requirements for the Master's degree. Those with no background will require a minimum of two years of residence.

IV. Expenses

Tuition, fees, and other expenses for graduate students are for the most part the same as given on page 33 for undergraduate students.

Thesis-Binding Fee

All graduate students are required to pay for the expense of binding the original thesis which will be retained in the Institute

Library. Certain departments will also require a bound copy of the thesis to be deposited in the department's library.

Both of these expenses must be paid at the Library prior to registering for the thesis work. The receipt obtained from the Library will allow the student to register for the subject.

V. Candidacy for a Master's Degree

Admission to the Graduate School does not indicate that the student is a candidate for the Master's degree. A student enrolled in a graduate degree program, who has established an acceptable scholarship record and has completed half of the required program, may make application to the Director of the Graduate School to become a candidate for the degree.

Application for approval of candidacy for the advanced degree must be filed after completion of one-half of the required program and not later than twelve weeks prior to the date on which the degree is to be conferred.

VI. Requirements for Graduation

To be recommended for the Master of Science degree a candidate must have fulfilled the following requirements:

(a) Completed a course of study approved by the department in which he has been enrolled. The approved course of study is to have a minimum of 30 credit hours, including thesis. A minimum of 20 credit hours is to be spent in listed subjects, and the program should have no fewer than 5 credit hours of thesis work.

(b) Completed a thesis (original research or other investigation, optional with department) approved by the department in which he has been enrolled, and successfully passed any oral or written examinations on his thesis required by the department at the time his thesis is submitted for final approval.

(c) Maintained residence for at least one academic year.

(d) Maintained an average rating of B in graduate subjects and passed all undergraduate subjects submitted for graduate credit with a grade of B or better.

UNDERGRADUATE PROGRAMS OF STUDY

Nine fields of study are open to the undergraduates. All are four years in length and lead to the degree of Bachelor of Science. These fields are:

- Electronic Engineering
- Leather Engineering
- Paper Engineering
- Plastics Engineering
- Textile Chemistry
- Textile Engineering—Engineering Option
- Textile Engineering—General Manufacturing Option
- Textile Manufacturing
- Textile Sales and Management

These curricula are outlined in the following pages. They are under constant study and subject to revision whenever changes are necessary to enable the Institute better to fulfill its mission of service to Industry.

In all courses considerable work in practical industrial applications has been included in addition to the fundamental studies in the physical sciences, mathematics, and engineering. Classes in the humanities and social sciences have been woven into all curricula in a conscious effort to produce graduates not only with a thorough technical training but also with the broad cultural background which marks the educated man.

THE FRESHMAN PROGRAM

The first semester of the freshman year is common to all curricula except Electronic Engineering. With the start of the second semester of the first year, the student is permitted to undertake a limited amount of work in his field of specialization. However, continued emphasis is given to the fundamental studies in mathematics, physics, chemistry and humanities.

The program for all freshmen, except those enrolled in Electronic Engineering, during the first semester is as follows:

Freshman Year

First Semester

*AS	101	Air Science and Tactics	(2-1)2
CH	101	General Inorganic Chemistry	(4-3)5
EN	111	Engineering Drawing	(0-6)2
GS	111	English Composition	(3-0)3
†MA	101	College Mathematics	(3-2)4
		Total credit hours	16
*Alternate:			
GS	101	World Economic Geography	(2-0)2

In addition to the preceding schedule all non-veteran men students who are physically qualified must take physical education for the whole freshman year. This subject meets one hour per week for AFROTC students and two hours per week for all others. It carries no academic credit.

Freshman Orientation

The first week's program in the fall for entering freshmen is called Freshman Week. It is devoted to facilitating the adjustment of the new student to his physical and social surroundings. Under the sponsorship of the Office of the Dean of Students, a program of meetings, lectures and conferences will be presented in order to acquaint the entering class with the traditions, customs, rules and regulations, courses of instruction, organizations, recreational activities and other facilities of Lowell Technological Institute.

†Students with special mathematical aptitude and training will start their college mathematics with MA 102 and continue with MA 201 during the second semester.

All new students are required to attend the program of Freshman Orientation which carries no academic credits but is designed to make the freshman aware of his new responsibilities and to help him adjust himself to college life. It guides him in making the most efficient use of his time and talents, attempts to develop his ability to think for himself and react thoughtfully and intelligently to new ideas and viewpoints.

Electronic Engineering

The objective of the curriculum in Electronic Engineering is to provide the student with a sound foundation for a professional career in electronics. Toward this end he is given a thorough grounding in electronic science and engineering together with an intensive training in mathematics and physics.

In all courses in electronics and physics the techniques of experimental science and technology are emphasized by investigative work in the laboratory and lecture demonstrations in the classroom.

Studies in the humanities and social sciences form an important part of the program since these subjects broaden the student's outlook. They also serve to focus attention on the importance of non-technical knowledge in determining the student's ultimate level of responsibility in professional life. Emphasis is placed on the development of the student's ability to speak and write effectively so that he can express his thoughts and the results of his experimental investigations with clarity.

During each semester of the undergraduate program in Electronic Engineering a case study is made of some novel topic or situation occurring in industry or in the course of an engineer's professional work. This gives the student an opportunity to develop his ability to make reasoned judgments in complex situations wherein non-technical factors frequently are of paramount importance.

FRESHMAN YEAR

First Semester

*AS	101	Air Science and Tactics	(2-1)2
CH	101	General Inorganic Chemistry	(4-3)5
EN	113	Engineering Drawing	(0-3)1
GS	111	English Composition	(3-0)3
MA	101	College Mathematics	(3-2)4
PH	103	Elementary Engineering Physics	(4-0)4
		Total credit hours	19

*Alternate:

GS	101	World Economic Geography	(2-0)2

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	104	General Inorganic Chemistry	(2-0)2
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(2-2)3
MA	106	Elementary Engineering Mathematics	(5-0)5
PH	104	Elementary Engineering Physics	(5-0)5
		Total credit hours	18

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	331	Physical Chemistry	(3-1½)4
EL	201	Introductory Circuit Theory	(3-0)3
EL	203	Elementary Electricity and Magnetism Laboratory	(0-3)1
MA	207	Intermediate Engineering Mathematics	(4-0)4
PH	205	Intermediate Engineering Physics	(3-0)3
*Elective			(3-0)3
		Total credit hours	20

*Alternate and Elective:

GS	201	Economics	(3-0)3
		or	
		Other General Studies subject approved by the Department Head	(3-0)3

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
CH	332	Physical Chemistry	(3-3)4
EL	202	Introductory Circuit Theory	(3-0)3
EL	204	Elementary Electricity and Magnetism Laboratory	(0-3)1
MA	208	Differential Equations for Engineers	(3-0)3
PH	206	Intermediate Engineering Physics	(3-0)3
*Elective			(3-0)3
		Total credit hours	19

*Alternate and Elective:

GS	226	World History Since 1900	(3-0)3
		or	
		Other General Studies subject approved by the Department Head	(3-0)3

JUNIOR YEAR

First Semester

EL	301	Introduction to Physical Electronics	(3-0)3
EL	303	Electronic Circuits	(3-0)3
EL	305	Electronics Laboratory	(0-4)2
EL	307	Electromagnetic Devices and Machinery	(3-0)3
EL	309	Instrumentation and Electromagnetics Laboratory	(0-4)2
MA	301	Advanced Calculus for Engineers	(3-0)3
*Elective			3 or 4
		Total credit hours	19 or 20

*Electives:

AS	301	Air Science and Tactics	(4-1)4
GS	303	Psychology	(3-0)3
		Other General Studies subject approved by the Department Head	(3-0)3

Second Semester

EL	302	Introduction to Physical Electronics	(3-0)3
EL	304	Electronic Circuits	(3-0)3
EL	306	Electronics Laboratory	(0-4)2
EL	308	Electromagnetic Devices and Machinery	(3-0)3
EL	310	Instrumentation and Electromagnetics Laboratory	(0-4)2
MA	302	Advanced Calculus for Engineers	(3-0)3
*Elective			3 or 4
		Total credit hours	19 or 20

*Electives:

AS	302	Air Science and Tactics	(4-1)4
GS	224	The United States Since 1865	(3-0)3
		Other General Studies subject approved by the Department Head	(3-0)3

SENIOR YEAR

First Semester

EL	401	Industrial Electronics and Servomechanisms	(3-0)3
EL	403	Communication and Microwave Electronics	(3-0)3
EL	405	Introduction to Solid State Electronics	(3-0)3
EL	407	Experimental Electronic Techniques	(1-0)1
EL	409	Electronic Projects Laboratory	(0-4)2
EL	411	Applied Electronics Laboratory	(0-4)2
PH	411	Advanced Engineering Physics	(3-0)3
*Elective			3 or 4
		Total credit hours	20 or 21

*Electives:

AS	401	Air Science and Tactics	(4-1)4
GS	461	Personnel Management	(3-0)3
		Other General Studies subject approved by the Department Head	(3-0)3

Second Semester

EL	402	Industrial Electronics and Servomechanisms	(3-0)3
EL	404	Communication and Microwave Electronics	(3-0)3
EL	406	Introduction to Solid State Electronics	(3-0)3
EL	408	Experimental Electronic Techniques	(1-0)1
EL	410	Electronic Projects Laboratory	(0-4)2
EL	412	Applied Electronics Laboratory	(0-4)2
PH	412	Advanced Engineering Physics	(3-0)3
*Elective			2 to 4
		Total credit hours	19 to 21

*Electives:

AS	402	Air Science and Tactics	(4-1)4
GS	468	Business Finance	(2-0)2
		Other General Studies subject approved by the Department Head	(3-0)3

Leather Engineering

The concept of a leather engineer is new to the leather industry. The economic size of this industry as well as the scope and number of its problems warrants the careful training of individuals capable of handling the specific problems which arise in this industry.

The leather industry realizes that many of its products can be improved by the application of sound and intelligent research and development. The demand is growing for engineers having a basic understanding of the art of leather manufacturing.

In this curriculum, emphasis is placed on the fundamentals of engineering including mathematics, physics, chemistry, and theoretical and applied mechanics. These subjects are basic in any sound undergraduate program. Since the undergraduate student cannot be left with a great collection of tools which he does not understand, subjects are offered in the application of their basic scientific principles to leather technology.

In order properly to balance this program, subjects in general education are offered, since the engineer, as well as being trained to be a leader in his profession, must also be trained to be a leader in everyday economic, social and political affairs. He must also be trained to meet success, promotion, and the challenge of directing the work of others.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	104	General Inorganic Chemistry	(2-0)2
CH	124	Elementary Stoichiometry	(2-0)1
EN	112	Engineering Drawing	(0-6)2
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	19

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	121	Qualitative Analysis	(1-6)3
CH	201	Organic Chemistry	(3-3)4
EN	223	Applied Mechanics	(3-0)3
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
		Total credit hours	19

*Alternate:

GS	201	Economics	(3-0)3

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	214	Quantitative Analysis	(2-6)4
LE	202	Applied Leather Analysis	(1-4)2
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	19

*Alternate:

GS	202	Economics	(3-0)3

JUNIOR YEAR

First Semester

CH	331	Physical Chemistry	(3-1½)4
LE	301	Leather Manufacture	(3-6)5
LE	303	Leather Histology	(2-4)4
*Electives			6 or 7
		Total credit hours	19 or 20

***Electives:**

AS	301	Air Science and Tactics	(4-1)4
		Electives chosen in one of the following fields: Sales, Management, Humanities, Finance, or Research	

Second Semester

CH	332	Physical Chemistry	(3-3)4
LE	302	Leather Manufacture	(3-6)5
LE	304	Advanced Leather Histology	(2-4)4
*Electives			6 or 7
		Total credit hours	19 or 20

*Electives:

AS	302	Air Science and Tactics	(4-1)4
		Electives must be in the field selected in the first semester	

SENIOR YEAR

First Semester

EN	351	Statistical Methods	(3-0)3
LE	401	Leather Manufacture	(3-6)5
LE	405	Leather Seminar	(1-0)1
PH	321	Electronics	(3-1)3
*Electives			6 or 7
		Total credit hours	18 or 19

*Electives:

AS	401	Air Science and Tactics	(4-1)4
		Electives must be in the area of studies selected in the Junior year	

Second Semester

EN	344	Electrical Machinery	(3-2)4
LE	402	Leather Manufacture	(3-6)5
LE	404	Properties of Leather	(2-3)3
LE	406	Leather Seminar	(1-0)1
*Electives			6 or 7
		Total credit hours	19 or 20

*Electives:

AS	402	Air Science and Tactics	(4-1)4
		Electives are to be chosen in the special field selected in the Junior year	

Paper Engineering

The object of this course is to fit a man for work in the paper-making, paper-converting, or allied industries. For this, a thorough training in basic chemical engineering is offered, accompanied by instruction in the theory and practice of pulp and paper manufacture and paper converting.

Paper engineering involves the application of cellulose and plastics chemistry together with engineering principles to the handling of the material in the web or sheet form, as it is treated, coated, or converted into the final product. Every effort is made by cooperation with local concerns to supplement college work by experience in actual manufacturing conditions, thus giving the student an opportunity to familiarize himself with equipment commonly in use in the industry.

Students taking this course should be well equipped for work in the paper-making or paper-converting fields, or for graduate study in paper technology.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	104	General Inorganic Chemistry	(2-0)2
CH	124	Elementary Stoichiometry	(2-0)1
EN	112	Engineering Drawing	(0-6)2
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	19
*Alternate:			
GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	121	Qualitative Analysis	(1-6)3
CH	201	Organic Chemistry	(3-3)4
EN	223	Applied Mechanics	(3-0)3
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
		Total credit hours	19
*Alternate:			
GS	201	Economics	(3-0)3

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	214	Quantitative Analysis	(2-6)4
GS	210	Speech	(2-0)2
GS	212	Business English	(2-0)2
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	21
*Alternate:			
GS	202	Economics	(3-0)3

JUNIOR YEAR

First Semester

CH	331	Physical Chemistry	(3-1½)4
CH	333	Industrial Stoichiometry	(3-0)3
PA	301	Pulp and Paper Manufacture	(3-0)3
PA	303	Pulp Manufacture, Testing and Analysis	(2-6)4
PH	321	Electronics	(3-1)3
*Electives			3 or 4
		Total credit hours	20 or 21

*Electives:

AS	301	Air Science and Tactics	(4-1)4
		A General Studies subject	(3-0)3

Second Semester

CH	332	Physical Chemistry	(3-3)4
CH	352	Chemical Engineering	(3-0)3
CH	362	General Colloid Chemistry	(2-0)2
PA	302	Pulp and Paper Manufacture	(3-0)3
PA	312	Paper Manufacture, Testing and Analysis	(2-6)4
*Electives			3 or 4
		Total credit hours	19 or 20

*Electives:

AS	302	Air Science and Tactics	(4-1)4
		A General Studies subject	(3-0)3

SENIOR YEAR

First Semester

CH	441	Advanced Chemical Engineering	(3-0)3
EN	351	Statistical Methods	(3-0)3
PA	405	Paper Converting Laboratory	(2-6)4
PA	407	Paper Coating and Converting	(3-0)3
*Electives			6 or 7
		Total credit hours	19 or 20

*Electives:

AS	401	Air Science and Tactics	(4-1)4
		General Studies subjects	

Second Semester

CH	442	Chemical Engineering Thermodynamics	(3-0)3
EN	344	Electrical Machinery	(3-2)4
EN	420	Industrial Instrumentation	(2-3)3
PA	408	Mill Inspection	(1-4)2
PA	414	Advanced Paper Problems	(2-6)4
*Electives			3 or 4
		Total credit hours	19 or 20

*Electives:

AS	402	Air Science and Tactics	(4-1)4
		A General Studies subject	(3-0)3

Plastics Engineering

This curriculum has as its objective the training of engineers specifically prepared to cope with the many technical and production problems found in the rapidly expanding field of plastics fabrication.

The emphasis is on the engineering principles involved in the fabrication of plastic materials into useful forms rather than the chemistry involved in the manufacture of the plastic material itself. Due to the close relationship involved between the physical and chemical properties of such materials, however, the curriculum involves considerably more chemistry than most engineering courses.

A basic training in mathematics and physics is required as well as elementary and advanced engineering subjects. In the third and fourth years this basic knowledge is focused on the problems of the plastics industry, including design, manufacture and testing.

Classes in the humanities and applied economics round out the education of the plastics engineer and equip him to advance to the administrative as well as the purely technological type of position.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	104	General Inorganic Chemistry	(2-0)2
CH	122	Qualitative Analysis	(1-6)3
CH	124	Elementary Stoichiometry	(2-0)1
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	20

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	201	Organic Chemistry	(3-3)4
CH	211	Quantitative Analysis	(2-6)4
GS	201	Economics	(3-0)3
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(4-2)5
		Total credit hours	21

*Alternate:

GS	223	The United States Since 1865	(3-0)3

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	212	Quantitative Analysis	(2-6)4
EN	122	Machine Tool Laboratory	(1-2)1
GS	202	Economics	(3-0)3
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	21

*Alternate:

GS	222	Appreciation of Literature	(3-0)3

JUNIOR YEAR

First Semester

CH	331	Physical Chemistry	(3-1½)4
CH	375	Chemistry of High Polymers	(2-3)3
EN	233	Machine Tool Laboratory	(0-3)1
EN	325	Applied Mechanics	(3-0)3
PL	301	Introduction to Plastics Technology	(3-3)4
**Electives			3 or 4
		Total credit hours	18 or 19

Second Semester

CH	332	Physical Chemistry	(3-3)4
CH	376	Chemistry of High Polymers	(2-3)3
EN	328	Strength of Materials	(3-0)3
PL	302	Introduction to Plastics Technology	(3-3)4
**Electives			3 or 4
		Total credit hours	17 or 18

SENIOR YEAR

First Semester

EN	351	Statistical Methods	(3-0)3
EN	405	Electronic Controls and Power Circuits	(3-2)4
PL	401	Advanced Plastics Technology	(3-6)5
PL	411	Plastics Seminar	(1-0)1
**Electives			6 or 7
		Total credit hours	19 or 20

Second Semester

EN	332	Engineering Materials	(2-0)2
EN	422	Industrial Instrumentation	(2-0)2
EN	508	Fluid Mechanics	(3-0)3
PL	402	Advanced Plastics Technology	(3-6)5
PL	412	Plastics Seminar	(1-0)1
**Electives			6 or 7
		Total credit hours	19 or 20

**Electives must include a prescribed sequence of subjects in one of the following optional cores:

Option I —Financial—GS 341, GS 342, GS 468, GS 211 or 212, GS 209 or 210
Option II —Humanities—GS 351 or 352, GS 303, GS 314, GS 205 or 206, GS 209 or 210, GS 211 or 212
Option III—Management—GS 341, GS 412, GS 461, GS 302, GS 209 or 210, GS 211 or 212
Option IV—Sales—GS 341, GS 351 or 352, GS 343, GS 431 or 432, GS 209 or 210, GS 211 or 212
Option V —AFROTC—AS 301-302, AS 401-402

Of the remaining elective credits at least three credits must be selected from the following:
EN 203, EN 510, EN 502, MA 206

Textile Chemistry

This curriculum is designed to prepare a student for the profession of chemistry, specifically as applied to the textile industry or to those related segments of the chemical industry which are engaged in the production of chemicals and fibers directly or indirectly used in textiles. Because of the broad scope of training in this curriculum, the student is prepared for positions in such related fields as research, development and production, and for those particularly suited, the curriculum provides a sound technical background for careers in sales or technical service.

This curriculum provides sound basic training in chemistry and in the related sciences of physics and mathematics. Training in chemistry includes both fundamental studies in inorganic, analytical, organic and physical chemistry and applied studies in fiber and cloth preparation, dyeing, printing and finishing.

Subjects in the humanities are included in the textile chemistry curriculum in order to provide the student with the broader background which may be required of him as he advances to more responsible positions in his chosen profession and in community and national life.

Students having difficulty in color perception are advised to take positions in those branches of textile chemistry which do not include work in dyehouses, or with dyestuff concerns where such a shortcoming would prove to be a serious disadvantage.

The following curriculum is applicable to the Class of 1958 and the Class of 1959. The program for the two upper classes will be found in the Catalogue Issue of 1954-1955.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	104	General Inorganic Chemistry	(2-0)2
CH	122	Qualitative Analysis	(1-6)3
CH	124	Elementary Stoichiometry	(2-0)1
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	20

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	201	Organic Chemistry	(3-3)4
CH	211	Quantitative Analysis	(2-6)4
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
TE	109	Introduction to Woven Structure	(2-1)2
		Total credit hours	19

*Alternate:

GS	261	Technical German	(3-0)3

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	204	Chemical Technology of Fibers	(2-0)2
CH	212	Quantitative Analysis	(2-6)4
MA	202	Mathematics for Chemists	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	19

*Alternate:

GS	262	Technical German	(3-0)3

JUNIOR YEAR

First Semester

CH	311	Textile Quantitative Analysis	(1-3)2
CH	321	Textile Chemistry	(2-3)3
CH	331	Physical Chemistry	(3-1½)4
GS	201	Economics	(3-0)3
TE	305	Elements of Textile Manufacture	(3-3)4

TE 403	Textile Evaluation	(2-2)3
*Electives		3 or 4
	Total credit hours	22 or 23

*Electives:

AS 301	Air Science and Tactics	(4-1)4
CH 333	Industrial Stoichiometry	(3-0)3
EN 351	Statistical Methods	(3-0)3
GS 361	Advanced Technical German	(3-0)3

Second Semester

CH 322	Textile Chemistry	(2-3)3
CH 332	Physical Chemistry	(3-3)4
CH 364	Textile Colloid Chemistry	(4-0)4
GS 202	Economics	(3-0)3
TE 300	Fabrics	(2-0)2
TE 404	Textile Evaluation	(2-2)3
*Electives		2 to 4
	Total credit hours	21 to 23

*Electives:

AS 302	Air Science and Tactics	(4-1)4
CH 312	Textile Quantitative Analysis	(1-3)2
CH 342	Organic Qualitative Analysis	(1-3)2
CH 352	Chemical Engineering	(3-0)3
GS 362	Advanced Technical German	(3-0)3

SENIOR YEAR

First Semester

CH 411	Advanced Textile Chemistry and Dyeing	(2-9)5
CH 421	Advanced Chemical Textile Testing	(2-3)3
GS 351	Elements of Marketing	(2-0)2
TE 409	Woolen and Worsted Finishing	(3-3)4
*Electives		4 to 6
	Total credit hours	18 to 20

*Electives:

AS 401	Air Science and Tactics	(4-1)4
	Other subjects approved by the Division Head	

Second Semester

CH 412	Advanced Textile Chemistry and Dyeing	(2-9)5
GS 302	Modern Labor Problems	(3-0)3
TE 408	Cotton and Synthetic Finishing	(3-3)4
*Electives		6 to 8
	Total credit hours	18 to 20

*Electives:

AS 402	Air Science and Tactics	(4-1)4
	Other subjects approved by the Division Head	

Textile Engineering

Engineering Option

In the Engineering Option of Textile Engineering, the student may obtain the broad fundamental training in engineering and science which is demanded by modern industry. There is a rapidly growing need in modern industry for men who are versatile in their engineering capabilities, who are soundly trained in the fundamentals which underlie all engineering, and who are therefore adaptable to assignment to numerous positions in the industrial organization of today.

This course provides a training in mechanical engineering similar to that found in other engineering schools. To this is added a knowledge of textiles sufficient to prepare the individual for positions in the textile and allied industries which may involve research and engineering principles. Business subjects and the humanities are included in the curriculum so that this type of textile engineer may have the educational potential to rise to a position of executive responsibility.

The following curriculum is applicable to the Class of 1959. The program for the three upper classes will be found in the Catalogue Issue of 1954-1955.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	102	General Inorganic Chemistry	(3-3)4
EN	114	Engineering Drawing	(0-3)1
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition	(3-0)3
†MA	102	College Mathematics	(3-2)4
		or	
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	102	Physics	(4-2)5
		Total credit hours	19 or 20

*Alternate:

GS	102	World Economic Geography	(2-0)2

†Those taking MA 102 must complete MA 201 before the beginning of the sophomore year. This normally means completing it at summer school.

SOPHOMORE YEAR

First Semester

*AS	201	Air Science and Tactics	(2-1)2
EN	203	Mechanism	(3-0)3
EN	207	Machine Drawing	(0-6)2
EN	233	Machine Tool Laboratory	(0-3)1
GS	201	Economics	(3-0)3
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
		Total credit hours	18

*Alternate:

General Study subject	(3-0)3

Second Semester

*AS	202	Air Science	(2-1)2
GS	202	Economics	(3-0)3
EN	222	Applied Mechanics	(3-0)3
EN	232	Engineering Materials	(3-2)4
MA	206	Differential Equations	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	19

*Alternate:

General Study subject	(3-0)3

JUNIOR YEAR

First Semester

EN	301	Advanced Applied Mechanics	(3-0)3
EN	305	Thermodynamics	(3-0)3
EN	351	Statistical Methods	(3-0)3
PH	321	Electronics	(2-2)3
TE	327	Elements of Textile Manufacturing	(3-3)4
*Electives			3 or 4
		Total credit hours	19 or 20

*Electives:

AS	301	Air Science and Tactics	(4-1)4
		General Studies subject	(3-0)3

Second Semester

EN	302	Advanced Applied Mechanics	(3-0)3
EN	342	Principles of Electrical Engineering	(3-2)4
EN	411	Advanced Heat Engineering	(3-2)4
TE	328	Elements of Textile Manufacturing	(3-3)4
*Electives			3 or 4
		Total credit hours	18 or 19

*Electives:

AS	302	Air Science and Tactics	(4-1)4
		General Studies subject	(3-0)3

SENIOR YEAR

First Semester

EN	401	Principles of Electrical Engineering	(2-2)3
EN	431	Advanced Physical Textile Testing	(2-3)3
GS	209	Speech	(2-0)2
GS	211	Business English	(2-0)2
GS	341	Accounting—I	(3-0)3
*General Studies elective			(3-0)3
†Technical electives			3
		Total credit hours	19

*Alternate:

AS	401	Air Science and Tactics	(4-1)4

†Technical electives:

EN	427	Machine Design	(2-3)3
EN	433	Manufacturing Tools and Methods	(3-0)3
PH	401	Textile Microscopy	(2-3)3
PH	503	Spectrographic Methods	(2-2)3
PH	505	X-ray Diffraction	(2-3)3

Second Semester

EN	420	Industrial Instrumentation	(2-3)3
EN	430	Engineering Design of Textile Structures	(3-0)3
EN	508	Fluid Mechanics	(3-0)3
GS	412	Industrial Management	(3-0)3
*General Studies elective			(3-0)3
†Technical electives			3 or 4
		Total credit hours	18 or 19

*Alternate:

AS	402	Air Science and Tactics	(4-1)4

†Technical electives:

EN	404	Heat Transfer	(2-0)2
EN	428	Machine Design	(2-3)3
EN	504	Air Conditioning	(2-2)2
PH	402	Textile Physics	(2-2)3
PH	504	Spectrographic Methods	(2-2)3
PH	508	Electron Microscopy	(1-3)2

Textile Engineering

General Manufacturing Option

A textile engineer is defined as one who has had a basic training in engineering to which has been added a thorough grounding in the manufacture of textiles, their properties and uses.

It is the belief that except in highly specialized areas, e.g., chemistry, the ideal training for the textile industry combines an understanding of textile processing relating to all fibers with a sound engineering and scientific background, as well as an orientation to society and business through a selected core of liberal arts and economic subjects.

The objective of the General Manufacturing Option is to provide the textile industry with technically trained textile engineers. The curriculum has been planned so that the textile engineer (1) will be given as complete and thorough a knowledge and understanding of the raw materials, machines, and processes peculiar to the manufacture of all fibers as is possible; (2) will have a basic training in engineering and the fundamental sciences; and (3) will acquire a knowledge of business and managerial principles and the social sciences.

The first component should prepare the student to be useful in any textile plant regardless of fiber processed. The second should develop a man who will approach textile problems from an engineering viewpoint, thus contributing toward their solution the benefits of a trained analytical mind. The third objective should aid in the production of a well-rounded individual.

The following curriculum is applicable to the Class of 1958 and the Class of 1959. The program for the two upper classes will be found in the Catalogue Issue of 1954-1955.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	102	General Inorganic Chemistry	(3-3)4
EN	114	Engineering Drawing	(0-3)1
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	20

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

AS	201	Air Science and Tactics or Alternate	(2-1)2
EN	201	Machine Drawing	(0-3)1
EN	203	Mechanism	(3-0)3
GS	201	Economics	(3-0)3
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
TE	203	Textile Fibers	(4-0)4
		Total credit hours	20

Second Semester

AS	202	Air Science and Tactics or Alternate	(2-1)2
EN	220	Textile Mechanism	(1-2)2
EN	326	Applied Mechanics	(3-0)3
GS	202	Economics	(3-0)3
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
TE	206	Yarn Manufacture	(3-3)4
		Total credit hours	21

JUNIOR YEAR

First Semester

CH	203	Elementary Organic Chemistry	(3-0)3
EN	327	Strength of Materials	(3-0)3
PH	321	Electronics	(3-1)3
TE	307	Yarn Manufacture	(3-3)4
TE	309	Fabric Manufacture	(2-2)2
*Electives			3 or 4
		Total credit hours	18 or 19

*Electives:

AS	301	Air Science and Tactics	(4-1)4
		General Studies subject	(3-0)3

Second Semester

CH	302	Introduction to Textile Chemistry	(1-3)2
EN	344	Electrical Machinery	(3-2)4
EN	352	Statistical Methods	(3-0)3
TE	308	Yarn Manufacture	(3-3)4
TE	310	Fabric Manufacture	(3-3)4
*Electives			3 or 4
		Total credit hours	20 or 21

*Electives:

AS	302	Air Science and Tactics	(4-1)4
		General Studies subject	(3-0)3

SENIOR YEAR

First Semester

EN	403	Principles of Heat Engineering	(3-2)4
GS	341	Accounting I	(3-0)3
TE	403	Textile Evaluation	(2-2)3
TE	405	Textile Finishing	(2-3)3
*Electives			6 or 7
		Total credit hours	19 or 20

*Electives:

		A General Studies subject	(3-0)3
		and one of the following:	
AS	401	Air Science and Tactics	(4-1)4
EN	507	Fluid Mechanics	(3-0)3
TE	407	Knitting	(2-3)3
TE	417	Cotton Mill Organization	(4-0)4

Second Semester

GS	210	Speech	(2-0)2
GS	212	Business English	(2-0)2
GS	412	Industrial Management	(3-0)3
TE	404	Textile Evaluation	(2-2)3
TE	406	Textile Finishing	(2-3)3
*Electives			6 or 7
		Total credit hours	19 or 20

*Electives:

		A General Studies subject	(3-0)3
		and one of the following:	
AS	402	Air Science and Tactics	(4-1)4
EN	420	Industrial Instrumentation	(2-3)3
EN	432	Advanced Physical Textile Testing	(2-3)3

Textile Manufacturing

This course of study is designed to equip students with a well-rounded understanding of the theory and principles of fundamental manufacturing processes. All common commercial fibers are studied regardless of whether they are animal, vegetable, mineral, or man-made.

This course covers a detailed study of such topics as source availability, properties, characteristics, uses, the methods of fiber manufacture; the operations or processes of marketing, grading, sorting; and other preparatory steps. It also covers the theory involved and application of fundamental manufacturing processing, such as fiber processing, yarn manufacture, fabric design, weaving, knitting, dyeing, finishing, testing, and evaluation.

The broad purpose is to prepare students as competent textile manufacturing technologists for eventual supervisory, administrative or executive positions. It is felt that this can best be done by a comprehensive course that covers the basic theory, principles and applications of all phases of textile manufacturing with all fibers and all processes.

This course leads to a B.S. degree and hence, such fundamental studies as mathematics, physics and chemistry are naturally included. However, a maximum amount of time is devoted to textile and such engineering subjects as are essential to a textile manufacturing technologist.

The humanities are included to provide a balanced education and to develop the student's ability to express himself clearly to others, as well as to give him an understanding of human behavior.

Any student completing this course of study should be well qualified ultimately to assume a position of responsibility in any phase of the textile manufacturing industry.

A Textile Fashion Option is available for women students and for men who are not enrolled in AFROTC classes. The purpose of this option is to provide interested students with the opportunity to take additional work in textile design and fashion in order to give them an understanding of the needs and operations of the fashion industry.

The following curriculum is applicable to the Class of 1958 and the Class of 1959. The program for the two upper classes will be found in the Catalogue Issue of 1954-1955.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	102	General Inorganic Chemistry	(3-3)4
EN	114	Engineering Drawing	(0-3)1
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	20

*Alternate:

GS	102	World Economic Geography	(2-0)2
		Textile Fashion Option	(1-4)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	203	Elementary Organic Chemistry	(3-0)3
EN	205	Mechanism	(3-2)4
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
TE	201	Textile Fibers	(4-0)4
		Total credit hours	20

*Alternate:

GS	205	Man and His Environment	(3-0)3
		Textile Fashion Option	(0-5)2

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
EN	352	Statistical Methods	(3-0)3
PH	202	Physics	(3-2)4
PH	204	Optical Instruments	(3-2)4
TE	202	Textile Fibers	(3-0)3
TE	204	Yarn Manufacture	(3-6)5
		Total credit hours	21

*Alternate:

GS	210	Speech	(2-0)2
		Textile Fashion Option	(0-5)2

JUNIOR YEAR

First Semester

EN	311	Heat and Power	(2-2)3
GS	201	Economics	(3-0)3
TE	301	Yarn Manufacture	(5-12)9
TE	303	Fabric Manufacture	(1-3)2
*Electives			3 or 4
		Total credit hours	20 or 21

*Electives:

AS	301	Air Science and Tactics	(4-1)4
		General Studies subject	(3-0)3
		Textile Fashion Option	(2-6)4

Second Semester

CH	302	Introduction to Textile Chemistry	(1-3)2
EN	304	Textile and Electronic Instrumentation	(2-2)3
GS	202	Economics	(3-0)3
TE	302	Yarn Manufacture	(3-6)5
TE	304	Fabric Manufacture	(2-3)3
*Electives			3 or 4
		Total credit hours	19 or 20

*Electives:

AS	302	Air Science and Tactics	(4-1)4
		or	
GS	352	Elements of Marketing	(2-0)2
		and	
GS	212	Business English	(2-0)2
		Textile Fashion Option	(2-6)4

SENIOR YEAR

First Semester

CH	401	Introduction to Textile Chemistry	(1-3)2
GS	301	Economic Development of the United States	(3-0)3
TE	401	Fabric Manufacture	(4-6)6
TE	403	Textile Evaluation	(2-2)3
TE	405	Textile Finishing	(2-3)3
*Electives			3 or 4
		Total credit hours	20 or 21

*Electives:

AS	401	Air Science and Tactics	(4-1)4
		General Studies subject	(3-0)3
		Textile Fashion Option	(1-8)4

Second Semester

GS	314	Philosophy of Science	(3-0)3
TE	402	Fabric Manufacture	(5-9)8
TE	404	Textile Evaluation	(2-2)3
TE	406	Textile Finishing	(2-3)3
*Electives			3 or 4
		Total credit hours	20 or 21

*Electives:

AS	402	Air Science and Tactics	(4-1)4
		General Studies subject	(3-0)3
		Textile Fashion Option	(2-6)4

TEXTILE FASHION OPTION

FRESHMAN YEAR

Second Semester

GS	122	Perspective Drawing	(1-1)1
GS	132	Freehand Drawing	(0-3)1

SOPHOMORE YEAR

First Semester

TE	273	Surface Design Fundamentals	(0-2)1
TE	281	Fashion Illustration	(0-3)1

Second Semester

TE	274	Applied Decorative Design	(0-2)1
TE	282	Fashion Illustration	(0-3)1

JUNIOR YEAR

First Semester

TE	311	Handloom Weaving	(0-3)1
TE	319	History of Costume and Adaptions	(1-2)2
TE	323	Color	(1-1)1

Second Semester

TE	324	Color	(1-1)1
TE	326	Cotton and Synthetic Design	(1-2)2
TE	352	Fabric Draping	(0-3)1

SENIOR YEAR

First Semester

TE	433	Pattern Drafting	(0-3)1
TE	435	Woolen and Worsted Design	(1-2)2
TE	437	Weaving Laboratory	(0-3)1

Second Semester

TE	442	Fashion Design and Construction	(1-4)2
TE	444	Jacquard Design	(1-2)2

Textile Sales and Management

This course is designed for those interested in the marketing and management phases of the textile and allied industries. Its emphasis is on all three branches of management—production, distribution, and finance.

The student is given a fundamental knowledge of the natural sciences and their application to the processing of all types of textile fibers. This scientific and manufacturing background is increasingly essential to effective merchandising and management, particularly at the higher levels of supervision.

A substantial amount of time is also devoted to cultural subjects designed to broaden the student's outlook, increase his understanding of social and economic problems, and improve his ability to get along with people.

A Textile Fashion Option is available for women students and for men who are not enrolled in AFROTC training. Details will be found in the description of the Textile Manufacturing curriculum.

The following curriculum is applicable to the Class of 1958 and the Class of 1959. The program for the two upper classes will be found in the Catalogue Issue of 1954-1955.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science and Tactics	(2-1)2
CH	102	General Inorganic Chemistry	(3-3)4
EN	114	Engineering Drawing	(0-3)1
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(3-2)4
PH	102	Physics	(4-2)5
		Total credit hours	20

*Alternate:

GS	102	World Economic Geography	(2-0)2
		**Textile Fashion Option	(1-4)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science and Tactics	(2-1)2
CH	203	Elementary Organic Chemistry	(3-0)3
GS	201	Economics	(3-0)3
MA	201	Analytic Geometry and Calculus	(3-0)3
PH	201	Physics	(3-2)4
TE	203	Textile Fibers	(4-0)4
		Total credit hours	19

*Alternate:

**Elective approved by Division Head

Second Semester

*AS	202	Air Science and Tactics	(2-1)2
EN	352	Statistical Methods	(3-0)3
GS	202	Economics	(3-0)3
GS	206	Man and His Environment	(3-0)3
PH	202	Physics	(3-2)4
TE	206	Yarn Manufacture	(3-3)4
		Total credit hours	19

*Alternate:

**Elective approved by Division Head

JUNIOR YEAR

First Semester

GS	311	Economic Statistics	(3-0)3
GS	321	Marketing Principles and Practices	(3-0)3
GS	341	Accounting I	(3-0)3
TE	307	Yarn Manufacture	(3-3)4
TE	309	Fabric Manufacture	(2-2)2
*Elective			3 or 4
		Total credit hours	18 or 19

*Electives:

AS	301	Air Science and Tactics	(4-1)4
		**Elective approved by Division Head	(3-0)3

Second Semester

CH	302	Introduction to Textile Chemistry	(1-3)2
GS	322	Marketing Principles and Practices	(3-0)3
GS	342	Accounting II	(3-0)3
TE	308	Yarn Manufacture	(3-3)4
TE	310	Fabric Manufacture	(3-3)4
*Elective			3 or 4
		Total credit hours	19 or 20

*Electives:

AS	302	Air Science and Tactics	(4-1)4
		**Elective approved by Division Head	(3-0)3

SENIOR YEAR

First Semester

GS	303	Psychology	(3-0)3
GS	343	Principles of Selling and Advertising	(3-0)3
GS	461	Personnel Management	(3-0)3
GS	463	Business Law	(3-0)3
TE	403	Textile Evaluation	(2-2)3
TE	405	Textile Finishing	(2-3)3
*Elective			3 or 4
		Total credit hours	21 or 22

*Electives:

AS	401	Air Science and Tactics	(4-1)4
		**Elective approved by Division Head	(3-0)3

Second Semester

GS	302	Modern Labor Problems	(3-0)3
GS	412	Industrial Management	(3-0)3
GS	466	Management Problems	(3-0)3
GS	468	Business Finance	(2-0)2
TE	404	Textile Evaluation	(2-2)3
TE	406	Textile Finishing	(2-3)3
*Elective			3 or 4
		Total credit hours	20 or 21

*Electives:

AS	402	Air Science and Tactics	(4-1)4
		**Elective approved by Division Head	(3-0)3

**The Textile Fashion Option is an approved elective; details concerning it will be found at the end of the preceding curriculum.

Subject Descriptions

All subjects offered at L.T.I. are listed alphabetically, regardless of the department involved, under the following headings:

AS	Air Science	LE	Leather
CH	Chemistry	MA	Mathematics
EL	Electronics	PA	Paper
EN	Engineering	PH	Physics
GS	General Studies	PL	Plastics
	TE	Textiles	

The number following the letter symbols is composed of three digits. The first digit of the number indicates the college year when the subject is normally presented, e.g., GS 111 is a freshman year subject; PA 414 is a senior year subject. Subjects numbered 500 and above are restricted to graduate students.

Except for basic mathematics, first semester subjects are designated by odd numbers and second semester subjects by even numbers. Hyphenated numbers indicate subjects continuing throughout the year.

Following the names of the individual subjects, the number of lecture-recitation and laboratory hours is indicated within the parentheses and the credit hour is shown outside. In the case of a year course the credit shown is the total for the year.

Examples of the above coding are as follows:

(2-6)4 means 2 hours of lecture-recitation and 6 hours of laboratory for 4 credits; (2-3) (1-6)6 indicates 2 hours of lecture-recitation and 3 hours of laboratory for the first semester followed by 1 hour of lecture-recitation and 6 hours of laboratory the second semester, for a total credit of 6.

The prerequisites for the various subjects are shown in brackets, e.g. [EN 111]. No student can be officially registered in a subject until the indicated prerequisites have been satisfactorily completed.

The following descriptions are valid for entering freshmen (Class of 1959) and reflect many changes, particularly in credit hours. Upperclassmen are cautioned to refer to the Catalogue Issue of 1954-1955 for information applicable to their classes.

AIR SCIENCE

AS 101-102 Air Science and Tactics I (2-1)(2-1)4

Introduces the AFROTC cadet to the history of aviation and its development into the jet air-age. Provides the student with a fundamental knowledge of principles of flight and aircraft engines and global geography, and acquaints him with the international tensions and security structures of various nations of the world. Leadership and Drill provides for the development in the student of the qualities of leadership and discipline essential to Air Force officers and acquaints him with the fundamentals of drill.

AS 201-202 Air Science and Tactics II (2-1)(2-1)4

Weapons, targets, types of aircraft, air operations, and bases. The USAF Officer Career Program is explained and a leadership laboratory is conducted in Officer Training.

AS 301-302 Air Science and Tactics III (4-1)(4-1)8

Navigation, weather, military law, problem-solving techniques, instructing in the Air Force, Air Force Commander and staff, Air Force communications, and base functions. Leadership laboratory.

AS 401-402 Air Science and Tactics IV (4-1)(4-1)8

Seminar in principles of personnel management. The framework of international politics; world powers and strategic areas; the security problem in relation to international power clashes. Principles of warfare and a historical survey of air warfare. Briefing for commissioned service and a leadership laboratory.

CHEMISTRY

CH 101 **General Inorganic Chemistry** (4-3)5

The basic principles of chemistry and a consideration of non-metallic elements and their compounds.

CH 102 **General Inorganic Chemistry** (3-3)4

[CH 101]

Metals and their compounds.

CH 104 **General Inorganic Chemistry** (2-0)2

[CH 101]

Metals and their compounds, with emphasis on the chemical principles involved rather than on the descriptive matter.

CH 121 or 122 **Qualitative Analysis** (1-6)3

[CH 101]

The systematic qualitative analysis of inorganic compounds through the use of semi-micro technique.

CH 124 **Elementary Stoichiometry** (2-0)1

[CH 101, MA 101]

The elementary calculations of inorganic chemistry and qualitative analysis.

CH 201-202 **Organic Chemistry** (3-3)(3-3)8

[CH 102 or 104]

The classification, structure, mechanism of reaction, and behavior in bulk of certain organic molecular species. Emphasis is given to the properties of organic substances of possible importance in industries based upon the use of organic polymers, such as the textile, paper, leather and plastics industries. The laboratory work attempts to illustrate properties of some of the classes of organic substances together with some of the techniques employed in organic laboratory operations.

CH 203 **Elementary Organic Chemistry** (3-0)3

[CH 102]

This subject enables students not majoring in chemistry to become conversant with the names, structural formulas, properties and uses of some important industrially-available organic substances and with the role which organic chemistry plays in industry and engineering.

CH 204 Chemical Technology of Fibers (2-0)2
[CH 201]

The chemical properties of the textile fibers and the reactions with chemicals and dyes which are of technical importance. Both natural and artificial fibers are considered.

CH 211-212 Quantitative Analysis (2-6)(2-6)8
[CH 104, 122, 124]

The fundamental principles of quantitative chemical analysis. The principles and calculations of gravimetric analysis, including separations involved in mineral samples as well as the analysis of soluble salts; the principles of colorimetry and electrodeposition; and the principles and calculations of volumetric analysis, including neutralization methods, permanganimetry, dichromate and cerate oxidimetry and iodimetry.

CH 213 or 214 Quantitative Analysis (2-6)4
[CH 102]

The principles and techniques of gravimetric and volumetric analysis for non-chemistry majors. The gravimetric portion stresses the fundamentals involved in the analysis of soluble salts; the volumetric methods include acidimetry-alkalimetry, oxidation-reduction, and iodimetry.

The lecture hours are devoted to a study of the underlying principles and mathematical calculations involved in the laboratory operations.

CH 302 Introduction to Textile Chemistry (1-3)2
[CH 102]
Not offered in 1955-1956

Lectures for the non-chemist on the various processes preliminary to dyeing. The preliminary treatments given the natural and manufactured fibers are studied as well as the action and properties of the textile chemicals used in these processes.

CH 311 Textile Quantitative Analysis (1-3)2
[CH 212]

The examination and evaluation of chemicals utilized in the textile mill, the dyehouse, and the finishing plant. Emphasis is placed on the practical techniques employed in the standard methods for bleaching agents, industrial water, soaps, oils, and synthetic detergents. Examples of fractional precipitation, complex methods and colorimetry are included.

CH 312 — Textile Quantitative Analysis — (1-3)2
[CH 311]

A continuation of CH 311 with emphasis on advanced analytical methods and an introduction to instrumental analysis. This option offers an opportunity for group and individual projects and includes report writing.

CH 321 — Textile Chemistry — (2-3)3
[CH 202, EN 104, PH 202]

This subject is designed primarily for those majoring in chemistry and is the first of four semesters of work relating to the chemistry of all types of textile fibers, i.e., cotton, wool, rayon, nylon, and synthetics. Lectures are given on operations preliminary to dyeing and on the physical organic chemistry of dyes. Operations preliminary to dyeing are carried out in the laboratory.

CH 322 — Textile Chemistry — (2-3)3
[CH 321]

A continuation of CH 321. Water in the textile industry, theory of dyeing, coloring matters, and dyeing processes.

CH 331-332 — Physical Chemistry — (3-1½)(3-3)8
[CH 124, CH 212, MA 202, PH 202]

The important principles of physical chemistry, i.e., gaseous, liquid, solid states; elementary chemical thermodynamics; determination of molecular weights; viscosity; surface tension; etc. Topics covered include dilute solutions, chemical equilibrium, phase equilibrium, free energy, and electrical properties of solutions.

CH 333 — Industrial Stoichiometry — (3-0)3
[CH 124, CH 213, PH 201]

A study of some important operations in the chemical industry, e.g., sulfuric acid, and in the pulp and paper industry from the standpoint of the application of reaction rate, mass and energy balance to prediction of performance, yield, etc. Recirculatory processes will also be studied.

CH 342 — Organic Qualitative Analysis — (1-3)2
[CH 122 and 202]

The standard non-physical methods of identification of unknown samples of organic substances which have been previously reported in the chemical literature.

CH 352 **Chemical Engineering** **(3-0)3**

[CH 104, CH 331, MA 202, PH 202]

Descriptive and quantitative information on unit conversion, dimensional analysis, materials of construction, flow of fluids, flow of heat, hygrometry, humidification, dehumidification, and drying.

CH 362 **General Colloid Chemistry** **(2-0)2**

[CH 331]

The basic general principles of colloidal chemistry, followed by elementary analyses of important problems encountered in amorphous materials such as paints, cellulosic products, leather, paper, and textiles.

CH 364 **Textile Colloid Chemistry** **(4-0)4**

[CH 331]

Basic principles of surface and colloidal chemistry and their applications in industry. Special emphasis is placed on applications to the textile field: wetting, detergency, and finishing processes, as well as the colloidal behavior of the fibers themselves.

CH 375-376 **Chemistry of High Polymers** **(2-3)(2-3)6**

[CH 202]

Not offered in 1955-1956

Definition and classification of high polymers; chemistry of the more important polymers including preparation, physical properties and chemical properties; mechanism and procedures for polymerization, copolymerization and condensation; physico-chemical investigations including molecular weight determination and distribution; the structure of high polymers including relationship of structure to properties; inter- and intra-molecular forces; states of aggregation; transition points; elasticity; viscoelastic behavior; cross linking; plasticization (internal and external); solvent action.

CH 401 **Introduction to Textile Chemistry** **(1-3)2**

[CH 302]

Not offered in 1955-1956

A continuation of CH 302. The application of various classes of dyes to natural and manufactured fibers. Methods of dyeing, fastness properties of different classes of dyes, the nature and use of dyeing assistants are stressed.

CH 411-412 **Advanced Textile Chemistry and Dyeing** **(2-9)(2-9)10**

[CH 322]

A continuation of CH 321-322, covering: coloring matching and color combining; dye testing and evaluation; union dyeing; printing, and dye house management.

CH 414 **Special Studies in Dyeing** **(1-3)2**
[CH 412 or permission of instructor]

A subject designed for those desiring more than the required work in dye application. Further work in dye application is given, also dye testing, color matching, and textile printing.

If the student has a particular problem in the application of dyes, time will be allotted for its study.

CH 415 or 416 **Theory of Dyeing** **(2-0)2**
[CH 322]

Fundamental chemical and physical aspects of the dyeing of protein, cellulose, and synthetic fibers. Consideration is given to the reaction of dyes with fibers, effects on dyeing of chemical and physical variations in fibers, and of chemical and physical processing of fibers, and the effects of variations in industrial dyeing techniques.

CH 421 or 422 **Advanced Chemical Textile Testing** **(2-3)3**
[CH 212 and 364]
CH 421 not offered in 1955-1956

Chemical methods of textile testing. Quantitative as well as qualitative determination of fiber content, finishing agents and dyestuffs on the fiber, fiber damage, etc. Optical methods of analysis and evaluation.

CH 441 **Advanced Chemical Engineering** **(3-0)3**
[CH 352]

A continuation of CH 352. The unit operations of evaporation, gas absorption, filtration and washing.

CH 442 **Chemical Engineering Thermodynamics** **(3-0)3**
[CH 332]

A study of the first law of thermodynamics. Heat capacity, perfect gases, phase rule and generalized pressure, volume and temperature relations. An introduction to the second law.

CH 451-452 **Organic Chemistry of Polymeric Materials** **(3-0)(3-0)6**
[CH 202, 321, 332]

The classification, mechanism of formation, structure, and properties of polymeric and amorphous materials arising from organic monomers and natural sources.

CH 461 or 462 **Microbiology** **(1-3)2**
[CH 202]

This subject considers the fundamentals of mycological and bacteriological theory briefly but in suffcient detail so that the prob-

lem of the microbiological deterioration of textiles, paper, and leather may be discussed.

Methods of detecting mildewing, methods of testing textiles for mildew resistance and bacteriological water analysis are also studied.

CH 464 Advanced Microbiology (1-3)2
[CH 461 or 462]

Work is arranged according to the interests of the individual student. Laboratory exercises such as the identification of pure cultures, the comparison of commercial mildewproofing agents, etc. are typical.

CH 472 Inorganic Preparations (2-3)3
[CH 104]

The reactions and processes of inorganic chemistry which are more used in commercial practice than in the laboratory. Experiments are chosen in conference between student and instructor.

CH 473-474 The Theory of Atomic and Molecular Structure (2-0)(2-0)4

This subject includes a discussion of past and modern theories of atomic structure including the application of wave mechanics to an understanding of the chemical bond. Additional topics include periodic classification of the elements, types of chemical bonds, structure of complexes and theories of acids and bases. The second semester is devoted to descriptive chemistry of the elements hydrogen, oxygen, nitrogen, carbon and boron families; the alkali and coinage metals; alkaline earth metals; zinc family and the transitional elements. Where possible, illustrations will be given of applications of inorganic materials to the textile, leather, paper and plastics industries.

CH 475 or 476 Special Studies in Physical Chemistry (1-3)2
[CH 331-332]

Open to seniors and graduate students who have shown interest and aptitude for physical chemistry.

An opportunity for those especially interested in the methods of physical chemistry to do further work in the laboratory. Preference will be given to those who wish to investigate the application of recent techniques which may be applied in industry.

Laboratory work and conferences as arranged with instructor.

CH 481 or 482 Tracer Techniques (1-3)2
[Permission of Instructor]

The use of radioactive substances as tracers. In the laboratory the fundamental techniques of counting, Feather analysis, "hot lab." syntheses, radioautographs, etc., are covered. The safe handling of radioactive materials at the microcurie level will be stressed.

CH 491 Textile Chemistry Literature Seminar (2-0)2
[Permission of Instructor]

A study and discussion of current textile chemistry literature, stressing the critical analysis of the subject matter.

CH 501 Color Measurement for Textile Chemists (1-3)2
[CH 421 or equivalent]

The operation and use of transmission and reflection colorimeters, spectrophotometers, and recording spectrophotometers is studied by means of lectures and laboratory experiments. The calculation of results and the use of the instruments in dye application research are also investigated.

CH 503 Interpretation of Data (2-0)2

Mathematical methods of analyzing, plotting and interpreting experimental data, which lead to properly weighted quantitative results, are studied by means of lectures and exercises.

CH 505 Physical Chemistry of Dyeing (2-3)3

A combination of lectures, seminars, and laboratory experiments on the physico-chemical principles involved in the application of dyestuffs to textile materials.

CH 511 or 512 The Physical Chemistry of Surface-Active Agents (1-3)2
[CH 364]

A series of lectures and laboratory experiments on the physico-chemical principles involved in the use of surface-active agents in textile processing. The surface and bulk properties of the agents are studied and related to the over-all technical properties and uses.

CH 516 Chemical Thermodynamics (2-0)2

Lectures on the principles of thermodynamics and their applications to chemical and physical problems.

CH 521 or 522 Textile Testing Problems (1-3)2
[CH 421]

Special problems relating to the design and evaluation of improved analytical or testing procedures.

CH 525 or 526 Evaluation of Finishing Agents — Credits and hours to be arranged
[TE 312]

A laboratory study designed to teach the use of the various test methods and instruments in evaluating the effect of finishing treatments on the tactile and end-use properties of a fabric.

CH 527 Instrumental Methods in Textile Research (1-2)2

The use of instruments in textile chemical research. The lectures cover the general principles of instrumentation in the various fields considered. The laboratory exercises invoke the use of specific instruments and are designed to teach the student to make a proper choice of instrumental methods in common textile chemical problems.

CH 531-532 Textile Chemistry Seminar (2-0) (2-0)4

A series of informal discussions of current problems in research and technology in the textile chemistry field. Special investigations of the literature will be utilized to serve as a source of seminar topics.

CH 541-542 Graduate Thesis Credits to be arranged

The graduate thesis is to be an independent investigation of a problem by the student in conference with a faculty advisor and approved by the Department Head. A clear and systematic written presentation of the results is a required part of this subject.

ELECTRONICS

EL 201-202 Introductory Circuit Theory (3-0)(3-0)6
[MA 106 and PH 104; MA 207-208 and PH 205-206 taken concurrently]

An introduction to the study of the mathematical and physical aspects of electric circuits in which radiation in the form of electromagnetic waves does not play a major role. Resistive circuits, Kirchoff's laws, Thevenin's theorem, reciprocity theorem, superposition theorem, impedance concept, impulse and step function response of simple circuits, sinusoidal steady-state behavior, vector diagrams, resonance, transients in alternating current circuits, loci of complex functions, polyphase systems, and an introductory discussion of simple non-linear circuits.

Text: Guillemin, *Introductory Circuit Theory.*

EL 203-204 Elementary Electricity and Magnetism Laboratory (0-3)(0-3)2
[PH 104; EL 201-202 taken concurrently]

The purpose of this subject is to give the student a working knowledge of the use of common electrical devices and measuring equipment as well as practice in the preparation of circuit drawings, the writing of technical reports and the analysis of the precision of measurements. Some attention will be given to the practical techniques useful in the construction of electrical equipment and accessories. Among the topics considered in the laboratory are: measurements of resistance, capacitance, inductance and impedance; DC and AC bridge circuits; magnetic measurements; characteristics of vacuum tubes and other non-linear devices; elementary vacuum tube circuits; AC and DC motors, and transformers.

Texts: Stout, *Basic Electrical Measurements;* Dunn and Barker, *Electrical Measurements Manual.*

EL 301-302 Introduction to Physical Electronics (3-0)(3-0)6
[EL 202 and MA 208]

The motion of charged particles in electric and magnetic fields, electronic phenomena in metals, statistical electron theory of metals, characteristics of thermionic cathodes, kinetic theory of gases, fundamental processes in gases, electrical discharges in gases, rectifiers and filters, photoelectricity, diodes, gas tubes, photoelectric cells, triodes and multielectrode tubes.

Text: Millman and Seely, *Electronics.*

EL 303-304 Electronic Circuits (3-0)(3-0)6

[EL 202 and MA 208; EL 301-302 taken concurrently]

Characteristics of electronic tubes; graphical solutions for circuits containing non-linear elements; linear equivalent circuits; combinations of resistive, capacitive and inductive elements; response of basic circuits to simple wave forms; amplifiers; oscillators; clamping, clipping, and trigger circuits; voltage regulating circuits; multivibrators and counting circuits.

Texts: Ryder, *Electronic Engineering Principles;* Corcoran and Price, *Electronics.*

EL 305-306 Electronics Laboratory (0-4)(0-4)4

[EL 202, EL 204 and PH 206; EL 303-304 taken concurrently]

The purpose of this subject is to give the student a good working knowledge of a number of electronic circuits and the techniques of measurement for evaluating their performance. A number of these circuits are assembled by the student. Further training is provided in the analysis and reporting of experimental work. Development of the student's initiative, resourcefulness and independent judgment is encouraged.

Text: Reed, Wagner and Corcoran, *Electrical Communications Experiments.*

EL 307-308 Electromagnetic Devices and Machinery (3-0)(3-0)6

[EL 202, MA 208, and PH 206; MA 301-302 taken concurrently]

Dimensional analysis, free and forced response of dynamic systems, electromechanical analogies; electromagnetic, piezoelectric, magnetostrictive, electrothermal and electromechanical devices; indicating and recording equipment, electrical computers, and fractional horsepower motors.

Texts: Olson, *Dynamical Analogies;* Thaler, *Elements of Servomechanism Theory;* Den Hartog, *Mechanical Vibrations.*

EL 309-310 Instrumentation and Electromagnetics Laboratory (0-4)(0-4)4

[EL 202, EL 204, and PH 206; EL 303-304 taken concurrently]

The purpose of this course is to familiarize the student with the construction and operation of various electromechanical devices and motors encountered in practice. Some attention will be given to the study of the dynamic performance of these devices. The preparation of carefully written technical reports will be encouraged.

Text: Fitzgerald and Kingsley, *Electric Machinery.*

EL 401-402 **Industrial Electronics and Servomechanisms** **(3-0)(3-0)6**

[MA 302 and EL 304]
Not offered in 1955-1956

A survey of industrial electronic control systems. Among the topics considered are: selsyns, amplidynes, regulators, servomechanisms, magnetic amplifiers, saturable reactors, inverters, high-current rectifiers, and high-voltage machines.

Texts: Brown and Campbell, *Principles of Servomechanisms;* Davis and Weed, *Industrial Electronic Engineering.*

EL 403-404 **Communication and Microwave Electronics** **(3-0)(3-0)6**

[MA 302 and EL 304]
Not offered in 1955-1956

Practice in the analysis of electronic systems. Beginning with zero frequency circuits, a study is made of the modifications required to give proper behavior as the frequency is increased. Among the topics considered are: radio frequency circuits, television circuits; amplitude, frequency, and pulse modulation; elements of electromagnetic theory, antennas, waveguides, microwave generators and receivers.

Text: Reich, et al, *Microwave Theory and Techniques.*

EL 405-406 **Introduction to Solid State Electronics** **(3-0)(3-0)6**

A broad survey of solid state electronics. Elements of crystal physics; elastic thermal and electrical properties of crystals; piezoelectricity; elements of the wave theory of matter; energy levels in solids; band theory of solids; Brillouin zones; Fermi-Dirac statistics; electron theory of metals; thermal and ionic diffusion; thermionic emission; field emission; electrical contacts; semi-conductors; rectification; transistor physics; insulators; radiation and atomic structure, photoelectricity and photoconductivity, secondary emission; magnetic, paramagnetic, and diamagnetic properties of solids; ferro- and ferri-magnetism; ferroelectricity; surface phenomena; adsorption, and catalysis.

Texts: Kittel, *Solid State Physics;* Shockley, *Electrons and Holes in Semiconductors.*

EL 407-408 **Experimental Electronic Techniques** **(1-0)(1-0)2**

Not offered in 1955-1956

Vacuum tube construction, vacuum technology, the metallurgical and mechanical properties of some metals, glass working, glass-to-metal seals, welding and soldering, phosphor and semiconductor technology, high-temperature properties of materials, behavior of materials at high frequencies, miniaturization of components, re-

liability of components, and the fabrication of electronic components.

Text: Braddick, *Physics of Experimental Method.*

EL 409-410 Electronic Projects Laboratory (0-4)(0-4)4

[EL 306 and 310]

Not offered in 1955-1956

In this subject the student is given the opportunity to develop, construct, study, modify, and test electronic components and systems. It is expected that he will carry out his investigations more or less independently. Original investigations will be encouraged but not required. The careful preparation of technical reports on the experimental work will be emphasized. Where practicable, the student will be expected to write his reports using the style of either the *Journal of the Institute of Radio Engineers* or the *Review of Scientific Instruments.*

Text: Wilson, *An Introduction to Scientific Research.*

EL 411-412 Applied Electronics Laboratory (0-4)(0-4)4

[EL 306 and 310]

Not offered in 1955-1956

The purpose of this subject is to give the student an experimental familiarity with the nature, application and performance of various electronic devices. Emphasis is given to the preparation of good technical reports.

Text: Terman and Petit, *Electronic Measurements.*

EL 501-502 Seminar in Electronics (1-0)(1-0)2

Discussion by staff members and students of current journal publications and topics of current interest in electronic science, electronic engineering and related areas of applied physics.

EL 503-504 Intermediate Solid State Electronics (3-0)(3-0)6

[EL 406]

Not offered in 1955-1956

An intensive study of selected topics in solid state electronics.

Texts: Shockley, *Electrons and Holes in Semiconductors;* Slater, *Quantum Theory of Matter.*

EL 505-506 Electronic Control and Measurement (3-0)(3-0)6

[EL 304 or equivalent]

Not offered in 1955-1956

The basic principles of electronic devices used for control and measurement in applied science and engineering.

EL 507-508 Transients in Electromechanical Systems (3-0)(3-0)6
[MA 302 or equivalent]
Not offered in 1955-1956

Training in the formulation and solution of ordinary and partial differential equations which arise in the treatment of mechanical, acoustical, thermal and electrical systems. Extensive use is made of modern operational mathematical techniques.

Text: Gardner and Barnes, *Transients in Linear Systems.*

EL 509-510 Microwave Electronics (3-0)(3-0)6
[EL 404]
Not offered in 1955-1956

Elements of electromagnetic theory, transmission lines, impedance matching, waveguides, antennas, microwave oscillators and amplifiers, klystrons, magnetrons, and travelling wave tubes.

EL 511-512 Electromagnetic Theory (3-0)(3-0)6
[PH 412]
Not offered in 1955-1956

Maxwell's equations, stress and energy, the electrostatic field, the magnetostatic field, plane waves in isotropic media, cylindrical waves, spherical waves, radiation, and boundary value problems.

Text: Stratton, *Electromagnetic Theory.*

EL 513-514 Special Problems in Electronics — Credits and hours to be arranged

The purpose of this subject is to give the student an opportunity for individual study, under the direction of a staff member, of topics in or related to electronic engineering.

EL 515-516 Graduate Research — Credits and hours to be arranged
Not offered in 1955-1956

Supervised research on some problem in electronic science, electronic engineering, or in certain areas of applied physics. The results of the research are to be embodied in a thesis acceptable to the departmental committee on graduate study.

ENGINEERING

EN 111 — Engineering Drawing — (0-6)2

Freehand and mechanical drawing, including lettering, geometric construction, orthographic projection, isometric and cabinet drawing, and dimensions.

EN 112 — Engineering Drawing — (0-6)2

[EN 111]

A continuation of EN 111 which includes the following topics: auxiliary views, cross sections, advanced dimensioning, sketching of machine parts, working drawings, tracing and blueprinting, intersections, and developments.

EN 113 — Engineering Drawing — (0-3)1

An abbreviation of EN 111.

EN 114 — Engineering Drawing — (0-3)1

[EN 111]

A continuation of EN 111 and abbreviation of EN 112.

EN 122 — Machine Tool Laboratory — (1-2)1

The objective of this subject is to give the student an insight into the processing of metals through lectures and practical laboratory applications covering the basic machine tools such as the lathe, shaper, drill-press, and milling machine, and also the uses of measuring instruments, threads, and gears. Lectures and demonstrations cover topics such as pattern work, foundry practice, die-casting, welding, and forging.

EN 201 — Machine Drawing — (0-3)1

[EN 112]

Several short problems involving centers of gravity, counterweights, cam layouts, piping, welding, sheetmetal drafting, and assembly drawings.

EN 203 — Mechanism — (3-0)3

The basic principles of kinematics, in which the wide variety of process machinery available furnishes many specific examples. Frequent use of these mechanisms is made in the development of the subject. Some of the important topics covered are the following: rolling cylinders and cones, gearing, gear train design, epicyclic gear trains, flexible connectors including stepped pulley and cone design, cam design, linkages, and miscellaneous mechanisms.

EN 205 **Mechanism** (3-2)4

[PH 102]

Similar to EN 203, except that laboratory time has been provided to allow study of textile mechanisms.

EN 207 **Machine Drawing** (0-6)2

[EN 112]

Problems involving centers of gravity, counterweights, cam layouts, piping, welding, sheetmetal drafting, and assembly drawings.

EN 220 **Textile Mechanism** (1-2)2

[EN 203]

The graphical and mathematical analyses of advanced mechanism found in textile machinery. The forces in, and velocities of, the various members of the mechanism are determined from actual data taken from the machines by the student himself.

EN 222 or 223 **Applied Mechanics** (3-0)3

[MA 201, taken concurrently if necessary, and PH 102]

The fundamentals of statics and kinetics, including such topics as force systems, laws of equilibrium, centers of gravity, moments of inertia, analysis of stresses in framed structures, momentum, energy, work and power, and the dynamics of the translation and rotation of rigid bodies.

EN 232 **Engineering Materials** (3-2)4

[PH 201]

Not offered in 1955-1956

The manufacture, properties, and uses of important ferrous and non-ferrous metals; hot and cold processing, alloying, heat treatment; also the properties and use of non-metallic engineering materials such as timber, cement, concrete, rubber, plastic, and mechanical fabrics.

EN 233 **Machine Tool Laboratory** (0-3)1

A continuation of EN 122, giving practical and more detailed instruction in such operations as lay-outs, filing, drilling, planing and shaping, and placing special emphasis on precision work.

EN 301-302 **Advanced Applied Mechanics** (3-0)(3-0)6

[EN 222, MA 202]

Strength of materials, including such topics as simple stresses, strain, bending moments, shearing force, slopes and deflections in beams, beam design, torsion, and design of shafts.

The work of the second semester deals with continuous beams,

compound beams and columns, eccentric loading, combined stresses, reversals of stress, impact stresses, vibrations, and stress analysis by strain gage methods.

EN 304 Textile and Electronic Instrumentation (2-2)3
[PH 202]
Not offered in 1955-1956

A study of indicating and recording instruments used to measure such common textile process variables as pressure, temperature, humidity, liquid level, fluid flow, etc. An introduction also to electronic circuitry as it relates to textile processing instrumentation controls.

EN 305 Thermodynamics (3-0)3
[MA 202, PH 201]

Properties of gases and vapors, reversible and irreversible cycles, mixtures of gases, combustion, and products of combustion.

EN 311 Heat and Power (2-2)3
[PH 201]
Not offered in 1955-1956

Similar to EN 403 but briefer and designed for those not majoring in engineering.

EN 321 Strength of Materials (3-0)3
[MA 201, PH 102]

A more elementary and condensed treatment of EN 301-302.

EN 325 or 326 Applied Mechanics (3-0)3
[MA 201, taken concurrently if necessary, and PH 102]

The fundamentals of statics, including such topics as force systems, laws of equilibrium, friction, centers of gravity, moments of inertia, stress fundamentals, strain, bending moment and deflection.

EN 327 Strength of Materials (3-0)3
[EN 325]
Not offered in 1955-1956

A condensed treatment of EN 301-302, this subject covers such topics as beams, beam design, torsion, columns, combined stresses, reversals of stress and impact.

EN 328 Strength of Materials (3-0)3
[EN 325]
Not offered in 1955-1956

Principles of the strength of materials with special emphasis on their applications to plastics. Includes such topics as bending and shearing stresses, torsion, compound beams and columns, rever-

sals of stress, impact, vibrations, stress analysis by strain gage methods, concepts of creep and relaxation.

EN 331 **Mill Engineering** (3-0)3
[EN 222]

The various types of building construction in the textile industry, including details of construction from a study of actual blueprints, calculation of allowable floor loads, stresses in beams and columns, machinery layout and the use of the transit in elementary surveying.

EN 332 **Engineering Materials** (2-0)2
[PH 201]

The manufacture, properties, and uses of important ferrous and non-ferrous metals; hot and cold processing, alloying, heat treatment; also the properties and use of non-metallic engineering materials such as timber, cement, concrete, rubber, plastic, and mechanical fabrics.

EN 342 **Principles of Electrical Engineering** (3-2)4
[PH 321]

The greater part of the subject is devoted to direct-current generators and motors with a study of their construction and characteristics. Three-phase circuits and alternators are also considered. The accompanying laboratory work illustrates the various methods of measuring polyphase power and of determining the characteristics of direct-current generators and motors.

EN 344 **Electrical Machinery** (3-2)4
[PH 321]

A condensation of EN 342 and EN 401.

EN 351 or 352 **Statistical Methods** (3-0)3
[MA 201]

The fundamental statistical measures and methods required for the analysis of experimental data; also the practical applications of statistical analysis to quality control and to the planning of industrial experiments.

EN 401 **Principles of Electrical Engineering** (2-2)3
[EN 342]

Alternator regulation, parallel operation, single-phase and three-phase transformers, induction motors and their applications to the textile industry, starting devices for motors, synchronous motors, and correction of power factor.

EN 403 — Principles of Heat Engineering — (3-2)4
[EN 203, MA 202, PH 201]

The basic principles of thermodynamics, properties of steam and its utilization in manufacturing processes, and the combustion of fuels. A brief treatment of steam engines, turbines and pumps. Special consideration is given to the use of steam in manufacturing processes.

EN 404 — Heat Transfer — (2-0)2
[MA 202, PH 201]

Conduction, convection, and radiation. Steady and unsteady state of conduction. Heat transfer in tubes and from plane surfaces. Heat exchangers, fin tube radiators, emissivity, and absorptivity.

EN 405 — Electronic Controls and Power Circuits — (3-2)4
[PH 201]
Not offered in 1955-1956

Power requirements in single-phase and three-phase power circuits; operating characteristics of various types of direct-current and alternating-current motors and their manual and automatic controls; industrial electronics including photoelectric relays, time delay relays, motor control, and side register control as applied in the plastics industry.

EN 411 — Advanced Heat Engineering — (3-2)4
[EN 305]

The kinematics of stationary steam generating units, reciprocating engines, steam turbines, pumps, condensers, and internal combustion engines. Special attention is given to the use of steam for processing purposes in industry.

EN 420 — Industrial Instrumentation — (2-3)3
[PH 201 and 202]

Similar to EN 422 with the addition of three hours of laboratory per week.

EN 422 — Industrial Instrumentation — (2-0)2
[PH 201 and 202]

Modern methods of measurement and control of the more common process variables such as temperature, pressure, liquid level, and fluid flow; response characteristics of mechanical, electric and electronic instruments; modes of control; associated mechanical and electrical mechanisms; characteristics of final control elements; closed-loop control systems; process characteristics and their effects upon the selection of the correct mode of control.

EN 427-428 **Machine Design** **(2-3)(2-3)6**
[EN 302 or 321]
Not offered in 1955-1956

The design of machine elements, such as fasteners, shafts, frames, bearings, gears, clutches, springs, keys and drives. Data for most of the problems are taken from actual machines in the various laboratories.

EN 430 **Engineering Design of Textile Structures** **(3-0)3**
Not offered in 1955-1956

This subject correlates engineering properties of textile materials, engineering principles, and textile processing in the design of textile structure with desired properties. The geometry of yarns and fabrics; design of textile structures for certain functional uses; prediction of dimensional changes which occur during use; stresses, strains, and energy changes which the end-use imposes; analyses of load-elongation diagrams of textile structural material.

EN 431 or 432 **Advanced Physical Textile Testing** **(2-3)3**

Compression testing, engineering properties of fibers and yarns, stress-strain-time phenomena of visco-elastic materials, theory and operation of strain gage testing machines, methods of measurement of yarn evenness, thermal transmission, flexibility of fabrics, fabric friction, bursting stress, and crimp. Use of the microscope in determination of wool quality, filament area and number. Statistical analysis of data.

EN 433 **Manufacturing Tools and Methods** **(3-0)3**
Not offered in 1955-1956

Designed to familiarize students with manufacturing methods and machines in general industrial work. Plant layout and planning; machine tool performance; power transmission and control; product evaluation and quality control.

EN 502 **Statistical Quality Control** **(3-0)3**
[EN 351 or 352]

A study of the various types of control charts for maintaining quality of manufactured products and of the several types of sampling plans for the reduced inspection of manufactured products and of raw materials. Applications of the foregoing statistical techniques to industry in general are discussed, with special emphasis on their application to the textile and other industries.

EN 503 or 504 **Air Conditioning** **(2-2)2**
[PH 201]

The fundamental principles of heating, ventilating, and refrigeration. The laboratory consists of design problems in the air conditioning of industrial buildings.

EN 505 or 506 Methods of Experimental Stress Analysis (3-1)3

[MA 202, PH 201 and 202, EN 302]

An introduction to some of the experimental techniques used in stress analysis. Photoelasticity, electrical strain gages, brittle coating, and mechanical gages are considered in relation to the analysis of both static and dynamic stresses. Special attention is given to the application of these techniques in the study of textile structures and machinery.

EN 507 or 508 Fluid Mechanics (3-0)3

[MA 202, PH 201]

Properties of fluids; statics of fluids; flotation; relative equilibrium; dynamics of fluids, Bernoulli's theorem, measurement of velocity and pressure; cavitation; flow of viscous fluids; Reynolds' number; flow in pipes; flow with free surface; critical depth; weirs; orifices and nozzles; impulse and momentum in fluids; resistance of immersed and floating bodies. Froude's number, boundary layer; dynamics of compressible fluids; Mach's number; dynamical similitude and Pi theorem.

EN 509 or 510 Advanced Statistical Methods (3-0)3

[EN 351 or 352]

A continuation of EN 351 or 352 with particular study of the more advanced statistical techniques as applied to the design of industrial experiments and to the analysis and interpretation of the resulting data.

EN 511-512 Graduate Thesis Credits to be arranged

Each graduate student in Textile Engineering is required to submit a thesis which shows ability and originality in the solution of a research project.

GENERAL STUDIES

GS 101-102 World Economic Geography (2-0)(2-0)4

Through a study of this subject the student gains an appreciation of the economic status of the different geographic areas of the world. The effect of climate, the geographic structure, and the distribution of important raw materials upon the activities of the people inhabiting those areas and on the types of industry which support the economic life of the various regions.

GS 111 English Composition (3-0)3

Thorough training in the fundamental rules of correct expression, grammatical principles, sentence and paragraph construction, and vocabulary development. A written theme is assigned each week.

GS 112 English Composition and Readings (3-0)3

A practical application of the principles studied in GS 111. The student is trained to express himself with clarity and accuracy and to think creatively when he is reading. Weekly assignments in an omnibus of essays and the writing of themes based on the outside readings or on other topics are required.

GS 122 Perspective Drawing (1-1)1

A mechanical method of representing objects of three dimensions showing correct proportions as they appear to the eye.

GS 132 Freehand Drawing (0-3)1

Freehand drawing of objects of different textures. Visual training and graphic expression to build a drawing vocabulary which will aid in advanced drawing subjects.

GS 201-202 Economics (3-0)(3-0)6

The principles and practices of economics and a brief study of economic history.

GS 205 or 206 Man and His Environment (3-0)3

The biological aspects of fundamental problems of heredity and environment which confront man in his economic, social, and cultural life. Emphasis is given particularly to the fields of ecology, genetics and eugenics, evolution, and anthropology.

GS 209 or 210 **Speech** **(2-0)2**
[GS 112]

The aim of this subject is to achieve effective delivery of various types of speech. All kinds of delivery are studied and analyzed.

GS 211 or 212 **Business English** **(2-0)2**
[GS 112]

Analysis and practice in letter writing and a study of the basic forms of technical exposition, forming a background for report writing in advanced courses and in industrial activity.

GS 222 **Appreciation of Literature** **(3-0)3**
[GS 112]

The principles of literary appreciation and criticism. An analysis of prose and poetical selections, with directed investigation of the various literary appeals—the intellectual, the sensory, the emotional, the aesthetic, the imaginative, and the philosophical.

GS 223 or 224 **The United States Since 1865** **(3-0)3**

A survey of the advancement of the American people from the Reconstruction Era through World War II.

GS 226 **World History Since 1900** **(3-0)3**

Particular attention is paid to the years 1919-1939 and such topics as the rise of new states; the origin and development of new concepts of nationalism, racism, and other phenomena; the alignment of world powers for World War II; and the role of the United States in mid-twentieth century reconstruction.

GS 261-262 **Technical German** **(3-0)(3-0)6**

The basic elements of German, leading to the development of reading ability in scientific German.

GS 301 **Economic Development of the United States** **(3-0)3**

An intensive study of current developments in the American economy, with emphasis in such fields as security, welfare, labor unionism, labor economics, ownership and management of industry, and trends in government regulation. Lectures, selected readings, and case material.

GS 302 **Modern Labor Problems** **(3-0)3**

Case material is studied to familiarize the students with Federal and State court actions, rulings of the National Labor Relations Board, and the functions of both public and private conciliators and arbitrators. At intervals during the semester, the class meets informally with representatives of both Labor and Management.

The chief objectives of this study are (1) a proper consideration of the important current issues in collective bargaining and (2) the development of familiarity with the techniques of the bargaining table and the problems in drafting, interpreting, and administering the modern labor contract.

GS 303 — Psychology — (3-0)3

The place of psychology in the life of the individual and society. Physiological bases of behavior and experience, attention, perception, memory, thinking, emotions, intelligence, and personality in terms of the whole person in his social setting.

GS 311 — Economic Statistics — (3-0)3

Basic concepts of the statistical method with special emphasis on those approaches of most interest to the student of management. Topics covered include: measures of central tendency, graphic methods, dispersion, skewness, sampling, normal curve, index numbers, correlation, time series, secular trend, seasonal variation, business cycle, and statistical forecasting.

GS 313 — Money and Banking — (3-0)3

Monetary and banking systems, particularly those in the United States. Monetary theory and standards, the Federal Reserve, individual bank management, fiscal and credit policies.

GS 314 — Philosophy of Science — (3-0)3

This subject analyzes the methods and techniques of inductive and deductive science. Elementary logic is studied and applied to the necessary structure of scientific systems. The great concepts and generalizations which have marked the history of science are reviewed and analyzed, as well as the interrelation of science and general philosophy.

GS 321-322 — Marketing Principles and Practices — (3-0)(3-0)6

GS 321 is an introduction to the basic principles of distributing goods with special emphasis on the textile industry. The selling agent, the commission man, the broker, jobber, merchant, factor, and other intermediaries.

GS 322 is a continuation of GS 321. Economic aspects of fashion, branding, sales promotion and advertising, market research, analysis of distribution costs, forecasting, market potentials, price policies, legal aspects of marketing, vertical integration, sales planning and control and the complete campaign.

GS 341 — Accounting - I — (3-0)3

The economic significance of accounting, the underlying accounting theories, and the organization and use of modern account-

ing records. The preparation and interpretation of reports and statements of financial position. The balance sheet, profit and loss statement, theory of debits and credits as applied to journalizing, and the usage of the various ledgers. Cost accounting methods and systems as applied to industry.

GS 342 Accounting - II (3-0)3

A continuation of GS 341 with emphasis on partnership and corporate records. Payroll and tax accounting; installment and branch accounting techniques. The peculiar aspects of manufacturing accounting are covered in detail, with the application of cost principles to this area.

GS 343 Principles of Selling and Advertising (3-0)3

The fundamental principles of advertising and salesmanship. Psychology of selling and advertising, copy writing, layout, printing and engraving, testing and research, planning an advertising campaign, government restrictions, types of media, radio advertising, trademarks, building a selling talk, fundamentals of salesmanship, types of personal selling, personality, retail salesmanship, training, etc.

GS 351 or 352 Elements of Marketing (2-0)2

A condensation of the more important elements of marketing covered in GS 321-322, designed to give the student an understanding of marketing as it affects wholesaling, retailing, and the consumer. Market research, advertising, branding, and vertical integration.

GS 361-362 Advanced Technical German (3-0)(3-0)6
[GS 262 or equivalent]

GS 361 may be taken without continuing GS 362.

This subject is designed to expand the student's elementary understanding of the language, to increase vocabulary, and to develop reading aptitudes in special fields of interest selected by the student.

GS 401 or 402 Industrial Relations Seminar (2-0)2
[Permission of Instructor]

This subject gives a small, selected group opportunities to meet with the instructor and occasional visitors in discussion of current problems in industrial relations. Case material and hypothetical problems in modern labor management provide the basis for group study.

GS 412 Industrial Management: Principles and Problems (3-0)3

Backgrounds of modern industry; organization of the industrial enterprise; the operation of modern industry; and coordina-

tion of the productive processes. Among the topics covered are: risks, forecasting, financing, product development, plant layout, production controls, personnel management, time and motion studies, job evaluation, and wage and salary administration. The text material is supplemented with current readings and case material.

GS 421 or 422 — Foreign Trade — (3-0)3
[GS 202]

The growth and development of foreign trade, international commercial policies, transportation and communication facilities, and international finance. The practical aspects of exporting and importing are emphasized.

GS 461 — Personnel Management — (3-0)3

A comprehensive study of modern labor management techniques in the recruiting, selection, training, and placement of members of the work force. Personnel administration agencies and procedures, with special attention to such matters as employee health and safety, welfare and recreation programs, wage and salary administration, training and education, and management relations with labor organizations.

GS 463 — Business Law — (3-0)3

The basic principles of commercial law including contracts, agency, sales, partnerships, corporation, negotiable instruments, bailments and carriers, insurance, personal property, real property, suretyship and guarantee, and bankruptcy.

GS 465 or 466 — Management Problems — (3-0)3
[Permission of Instructor]

Research for graduate students and selected seniors. Working under the guidance of the instructor, a student investigates an approved topic in the fields of finance, production, or distribution. The findings of the student are presented in formal thesis form. These theses are then placed in the department library for permanent record.

GS 468 — Business Finance — (2-0)2

The organization and financing of private enterprise, partnership, trust, and corporate types of business establishments. The stock and bond markets. Emphasis is placed on the study of the corporation in formation, operation, dissolution, and reorganization.

LEATHER

LE 202 — Applied Leather Analysis — (1-4)2
[CH 213]

A subject designed to acquaint the student with the accepted methods of analysis of the American Leather Chemists Association and other supplementary procedures.

LE 301-302 — Leather Manufacture — (3-6)(3-6)10

Introduction to the technology of leather manufacture. The first semester is devoted to examining government regulations in imported hides and skins, studying the purchasing of hides and skins, and classifying various hide damages. This is followed by work on the handling of raw stock at the tannery, unhairing, bating, and hide classification. The second semester is concerned primarily with the study of vegetable tanning, chrome tanning, and various other types of tanning. In the work throughout the year the material covered in lectures is supplemented by laboratory studies on a small scale.

LE 303 — Leather Histology — (2-4)4
[CH 201-202]

A study of the structures of animal skin and of the changes which they undergo in the leather-making process. Because the basically extracellular nature of skin demands it, considerable time is devoted to the nature and function of the fundamental protein constituents.

LE 304 — Advanced Leather Histology — (2-4)4
[LE 303]

A study of the fibers of leather in their relationship primarily to the mechanisms of tanning and secondarily to pathological situations and to the physical characteristics of leather.

LE 401-402 — Leather Manufacture — (3-6)(3-6)10
[LE 302]

A continuation of the study into the technology of leather manufacture covering the various currying treatments applied to rough leather such as fat liquoring, stuffing, dyeing and the various mechanical operations of setting, stretching, etc. It is intended to show how widely the physical properties of leather may be varied and controlled by the proper application and selection of these numerous operations and treatments.

LE 404 **Properties of Leather** **(2-3)3**
[EN 351 and LE 401]

A practical and theoretical study of the characteristics of leather in relation to the end use. Studies are made on measuring and classifying the effect of changes in manufacturing procedure, both chemical and physical. Leather, because it is a natural product, varies considerably within the same hide. Thus, the nature of this variation is very important and the study of any changes affecting it is, in turn, important.

LE 405 **Leather Seminar** **(1-0)1**

A seminar on recent advances in leather research. Written and oral reports are required, and time is devoted to techniques of proper presentation of these reports.

LE 406 **Leather Seminar** **(1-0)1**

A continuation of LE 405.

LE 411-412 **Leather Problems** **(1-6)(1-6)6**
[LE 302]

This subject is designed primarily to enable the student to put into practical application the various scientific principles of physics, chemistry, mathematics, economics, etc. on problems of an industrial nature. This may encompass anything from the design and layout of any of a number of special leather plants to the suggested solution of practical problems which arise in the operation of a modern leather business.

MATHEMATICS

MA 101 College Mathematics (3-2)4

Algebra and plane trigonometry. Algebra review through quadratics, logarithms and simultaneous equations, functions of angles, solution of right triangles, the slide rule, and the use of approximate data.

MA 102 College Mathematics (3-2)4

Trigonometric equations and identities, solution of oblique triangles, Cartesian coordinates, equations of curves, derivative of a function.

MA 106 Elementary Engineering Mathematics (5-0)5

[A grade of B or higher in MA 101]

An intensive study of the geometric properties and equations of curves, and the elements of differential and integral calculus. Stress is placed on the application of mathematics to problems in engineering. Topics studied include: graphical representation of functions; differentials and derivatives of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic and hyperbolic functions; integration of algebraic, trigonometric, exponential, and hyperbolic functions; analytic geometry of the straight line and conic sections; polar coordinates and parametric representation.

Texts: Thomas, *Calculus and Analytic Geometry;* Peirce, *A Short Table of Integrals.*

MA 201 Analytic Geometry and Calculus (3-0)3

[MA 102]

Differentiation of algebraic functions, maximum and minimum values, rates and differentials, the circle, parabola, ellipse, hyperbola, indefinite integrals, summation by integration, and applications of integration.

MA 202 Analytic Geometry and Calculus (3-0)3

[MA 201]

Applications of the fundamental theorem, diffentiation of transcendental functions, methods of integration, solid analytic geometry, polar coordinates, partial differentiation, and empirical formulas.

MA 206 Differential Equations (3-0)3

[MA 202]

A review of series and partial differentiation, first- and second-order differential equations, and first- and second-order partial differential equations. Practical applications for the chemist and the engineer.

MA 207 Intermediate Engineering Mathematics (4-0)4

[MA 106]

A continuation of MA 106. Methods of integration, elementary vector analysis, elements of solid analytic geometry, partial differentiation, multiple integrals, infinite series, and the elements of complex variable theory. Stress is given to the application of the mathematics to problems in applied science and engineering.

Texts: Same as in MA 106.

MA 208 Differential Equations for Engineers (3-0)3

[MA 207]

A general survey of ordinary differential equations and an introduction to partial differential equations and the Laplace transformation. Numerous applications are made to problems in physics, chemistry and geometry.

Texts: Reddick, *Differential Equations;* Jaeger, *Laplace Transformation;* Peirce, *A Short Table of Integrals.*

MA 301-302 Advanced Calculus for Engineers (3-0)(3-0)6

[MA 208]

Ordinary differential equations, Laplace transformation, numerical methods of solving differential equations, series solutions of differential equations, boundary value problems and orthogonal functions, vector analysis, partial differential equations, partial differential equations of mathematical physics, and complex variable theory.

Text: Hildebrand, *Advanced Calculus for Engineers.*

MA 501 Vector and Tensor Analysis (3-0)3

Not offered in 1955-1956

The algebra of vectors, differential vector calculus, differential geometry, integration, tensor analysis and Riemannian geometry. Frequent applications are made to problems in mechanics, hydrodynamics, elasticity, and electricity.

Text: Lass, *Vector and Tensor Analysis.*

MA 502 Matrix and Tensor Analysis (3-0)3

Not offered in 1955-1956

Matrix and tensor analysis and their applications to problems in engineering and physics.

Text: Sokolnikoff, *Tensor Analysis—Theory and Applications.*

MA 503 Complex Variables (3-0)3

[MA 206]

Not offered in 1955-1956

Complex numbers, series expansions of analytic functions, residues and poles, contour integration, conformal mapping, Schwarz-

Christoffel transformations, analytic continuation, Riemann surfaces, and multi-valued functions. Emphasis is given to topics considered most essential to physics and engineering.

Text: Churchill, *Introduction to Complex Variables.*

MA 504 Fourier Series and Boundary Value Problems (3-0)3

Not offered in 1955-1956

The theory of Fourier series and its application to the solution of boundary value problems. Bessel functions, Legendre polynomials, and Fourier integrals.

Text: Churchill, *Fourier Series and Boundary Value Problems.*

MA 505-506 Modern Operational Mathematics (3-0)(3-0)6

Not offered in 1955-1956

Applications of the Laplace transform technique to the solution of ordinary and partial differential equations with special reference to those which arise in the analysis of electrical circuits, mechanical vibrations, heat conduction, and automatic control problems.

Texts: Churchill, *Modern Operational Mathematics;* McLachlan, *Complex Variable Theory and Operational Calculus.*

MA 507-508 Methods of Applied Mathematics (3-0)(3-0)6

[MA 302]

Not offered in 1955-1956

The aim of this subject is to give the student a working knowledge of a number of facts and techniques relevant to the following topics: matrices, determinants, linear equations, linear vector spaces, characteristic-value problems; calculus of variations, Hamilton's principle and Lagrange's equations; difference equations; integral equations, Green's function, analytical and numerical methods for obtaining solutions of integral equations.

Text: Hildebrand, *Methods of Applied Mathematics.*

MA 509 or 510 Graphical Mathematics (0-6)2

[EN 112 and MA 202]

Graphical solutions in algebra, differential and integral calculus, and in space geometry, with analytical verification; nomographs.

PAPER

PA 301-302 Pulp and Paper Manufacture (3-0)(3-0)6
[CH 102]

Lectures on the production and technology of pulp and paper.

PA 303 Pulp Manufacture, Testing and Analysis (2-6)4
[CH 213]

An elementary study of the principal woods and pulping methods used in pulp manufacture. The lecture work is accompanied by laboratory training in wood and pulp microscopy, pulping techniques, and pulp testing and analysis.

PA 312 Paper Manufacture, Testing and Analysis (2-6)4
[CH 213]

An elementary study of the fundamental processing techniques used in paper manufacture. The lecture work is accompanied by laboratory training in paper making, paper testing and analysis, and paper microscopy.

PA 401-402 Practice Work in Industry (1-8)(1-8)8
[PA 302 and 312, or equivalent]

In order to give the student as thorough a knowledge of industrial problems and practices as possible, it is planned, in cooperation with several mills and converting plants, to set up practice stations. The student will spend one full day each week at one of these stations working on technical problems of interest to the mill management, but under the supervision of a member of the Institute staff. May be taken either or both semesters.

PA 403 Materials of Construction, Corrosion 2 credits
[PA 401 taken concurrently]

This subject, given at the practice stations, covers the common construction materials used in the industry and their ability to stand up under various conditions of use. It will be illustrated by examples in the plants studied.

PA 405 Paper Converting Laboratory (2-6)4
[PA 302 and 312]

Study and practice in the use of some of the common techniques employed in the paper converting industry. The laboratory work is designed with a research-type approach in an effort to develop the student's ability in planning his work.

PA 407 **Paper Coating and Converting** **(3-0)3**
[PA 312]

Coating, treating and impregnating, laminating, embossing, creping and, if time permits, printing.

PA 408 **Mill Inspection** **(1-4)2**
[PA 302 and 407]

Mill visits involving the observation of operations in various types of paper mills and converting plants. A formal report on each visit is required.

PA 412 **Industrial Cellulose Chemistry** **(1-0)1**
[CH 202]

The manufacture and use of the chief cellulose derivatives. Chemical treatments for cellulose in the paper and textile fields.

PA 414 **Advanced Paper Problems** **(2-6)4**
[PA 303 and 312]

This is designed to give the senior an opportunity to work upon a problem connected with some phase of the paper or paper converting industry. Problems will be selected by the student and staff in collaboration.

PA 501-502 **Graduate Thesis** **Credits to be arranged**

Every graduate student is required to prove his ability to carry on independent research by presenting a thesis on an approved subject.

PA 503-504 **Advanced Paper Microscopy** **(2-6)(2-6)8**

A study of the microscopic techniques and use of accessory equipment with emphasis on special papermaking and converting materials in process. Special attention is given to finished and converted products and their uses. Identification, distribution (mechanical and structural) and chemical effects. There is room for wide latitude of study, depending on student's interest.

PA 505-506 **Advanced Papermaking and Paper Converting** **(2-6)(2-6)8**

Non-fibrous raw materials used in the specialty papermaking and paper-coverting fields with emphasis on recent developments and new uses. These materials are studied with regard to their chemical and physical properties, the technology of application and processed sheet properties.

PHYSICS

PH 102 — Physics — (4-2)5

The basic principles of mechanics, including vector analysis, equilibrium of concurrent forces, equilibrium of non-current forces, rectilinear and curvilinear motion, inertia, harmonic motion, moment of inertia, conservation of energy, simple machines, hydrostatics and elements of hydraulics.

PH 103 — Elementary Engineering Physics — (4-0)4

Primarily for students in Electronic Engineering.

Composition and resolution of vectors, statics, moments, center of gravity, rectilinear motion, Newton's second law, motion of a projectile, work and energy, impulse and momentum, circular motion, rotation, elasticity, harmonic motion, hydrostatics, hydrodynamics and viscosity.

Text: Sears and Zemansky, *College Physics* (Part I).

PH 104 — Elementary Engineering Physics — (5-0)5

[A grade of B or higher in MA 101 and PH 103]

An intensive subject for students who wish to major in Electronic Engineering. Response of matter to temperature changes, conduction of heat, first and second laws of thermodynamics, wave motion and sound, electrostatics, direct-current circuits, magnetism, alternating-current circuits, electronics, optics, elements of atomic and nuclear physics.

Text: Sears and Zemansky, *University Physics* (Part II).

PH 201 — Physics — (3-2)4

[PH 102]

A continuation of PH 102. Thermometry, measurement of heat, change of state, expansion, transfer of heat, humidity, magnetism, electrostatics, fundamental laws of direct and alternating current circuits, motors and generators, and electronics.

PH 202 — Physics — (3-2)4

[PH 102]

Sound, light, and modern physics. Some of the topics are: wave motion, velocity of sound, characteristics of musical sounds, acoustics, reflection and refraction of light, lenses, optical instruments, color sensation, double refraction and polarization, and elements of nuclear physics.

PH 204 **Optical Instruments** **(3-2)4**
[PH 202 taken concurrently]

The basic laws of optics and their application to various optical instruments used in industry, such as the microscope, telescope, refractometer, and colorimeter. Considerable emphasis in the laboratory work is placed on the general use of the microscope.

PH 205-206 **Intermediate Engineering Physics** **(3-0)(3-0)6**
[MA 106 and PH 104; MA 207-208 taken concurrently]

The fundamental laws of electricity and magnetism presented from the point of view of field theory. Free use is made of the calculus. Topics in the first semester include: electrostatics, steady currents and their magnetic fields, induced electromotive forces and inductance, elementary alternating current circuits, and time dependent magnetic fields. In the second semester the following topics are studied: electromagnetic waves in free space, on wires, and in material bodies; behavior of electrons in metals, thermionic emission, dielectric and magnetic properties of matter, geometrical optics, physical optics, atomic structure and topics in modern physics.

Text: Frank, *Introduction to Electricity and Optics,* 2nd edition.

PH 301 or 302 **Advanced General Physics** **Credit and hours to be arranged**
[Permission of instructor]

Selected topics in mechanics, heat, sound, electricity, optics, and modern physics presented on an advanced level and emphasizing the interdependence of higher mathematics, classical physics, and practical concepts of engineering.

PH 321 **Electronics** *Tex. Eng.-Eng. Opt.* **(2-2)3**
Others **(3-1)3**
[PH 201]

The principles of alternating currents as a background for the understanding of electronic circuits. The elements of vacuum and gaseous tube characteristics and of circuits containing such tubes for the purpose of rectification, amplification, and oscillation. Industrial photoelectric relays, time delay relays, and Thymotrol motor controls.

PH 401 **Textile Microscopy** **(2-3)3**
[PH 202]

Applications of the microscope to textile materials. Methods of sectioning, measurement of cotton immaturity and mercerization, determination of denier of rayon, wool grading, fiber identification,

quantitative analysis of fiber mixtures and their practical applications. Some of the more advanced aspects of critical microscopy which are essential for the best visual work and photographic practice are considered. Some time is devoted to photographic work and the use of polarized light.

PH 402 — Textile Physics — (2-2)3

[MA 201, PH 201 and 202]

Textile Physics is designed primarily for graduate students but may be taken by seniors who have sufficient knowledge of elementary college physics, microscopy and testing. It deals in an analytical and experimental manner with the principles of advanced physics which have important applications to textile technology. The topics taken up include heat transmission of textile materials; color measurements; calculation of tristimulus values; transformation to dominant wave-length, colorimetric purity and brightness; measurement of refractive index of fibers; applications of phase microscopy; fluorescent microscopy; use of X-ray diffraction methods to determine crystal orientation and structure of fibers; spectrographic analysis; investigation of mineral elements in textile fibers; and accurate methods of measuring stress, strain, viscosity.

PH 411-412 — Advanced Engineering Physics — (3-0)(3-0)6

[MA 302 or permission of instructor]

Not offered in 1955-1956

The aim of this subject is to present a unified view of the various fields of classical physics and to show their relation to engineering.

Text: Menzel, *Mathematical Physics.*

PH 501 or 502 — The Physics of Color Measurement — Credit and hours to be arranged

[MA 202, PH 202]

The philosophy and practice of modern colorimetry. Colorimeters, their uses and limitations, spectro photometers, tristimulus values, dominant wave-length and purity, the "standard observer" concept, the Munsell system, the Ostwald system, color tolerances, gloss and body color, illuminants, and industrial applications.

Laboratory instruments available consist of brightness testers, monochromatic and trichromatic colorimeters, recording and visual spectrophotometers.

PH 503-504 — Spectrographic Methods — (2-2)(2-2)6

[PH 202]

The theory and application of the spectrograph for the qualitative and quantitative analysis of materials. The Bohr theory, quantum mechanics, atomic models, and the theoretical prediction

of line and bend spectra. Special attention is placed in the laboratory on the analysis of elements in paper, leather, and textile samples and individual problems are assigned to the students.

PH 505 or 506 **X-Ray Diffraction** **(2-3)3**
[PH 202]

The theory of X-ray diffraction and its application to the structure of matter. Special consideration is given to the taking and interpretation of diffraction data obtained from fibers used in paper and textile technology.

PH 507 or 508 **Electron Microscopy** **(1-3)2**
[PH 202]

Basic methods in the practice of electron microscopy including specimen preparation, use and operation of the electron microscope, vacuum techniques, and photography. This work is supplemented with special studies on selected topics.

PH 509-510 **Solid State and Modern Physics For Engineers** **(3-0)(3-0)6**

Elements of electronics, special theory of relativity, atomic structure of matter, quantum mechanics, x-rays, molecular structure and molecular spectra, low-temperature phenomena, natural and induced radioactivity, nuclear fission, cosmic rays and mesons, elements of crystal physics, specific heats, alloys of metals, elastic and plastic properties of solids, rupture and fatigue of solids, thermal diffusion, electron theory of metals and alloys, thermal and electrical properties of solids, energy levels in solids, cohesion in solids; magnetic, paramagnetic and diamagnetic properties of solids; magnetic moments and resonance, transistor physics, semi-conductors and electron diffusion in metals.

Texts: Kittel, *Solid State Physics;* Slater, *Quantum Theory of Matter.*

PH 513-514 **Elementary Quantum Mechanics** **(3-0)(3-0)6**
Not offered in 1955-1956

The postulational formulation of quantum mechanics. The basic theory is developed both in the operator and matrix formulations.

Text: Persico, *Fundamentals of Quantum Mechanics.*

PH 515 **Thermodynamics and Kinetic Theory** **(3-0)3**
Not offered in 1955-1956

The first, second, and third laws of thermodynamics, thermodynamic functions, chemical thermodynamics, thermodynamics of multicomponent systems, equations of state; elementary kinetic

theory, mean free path, thermal conductivity, viscosity, and transport phenomena.

Text: Allis and Herlin, *Thermodynamics and Statistical Mechanics.*

PH 516 Kinetic Theory and Statistical Mechanics (3-0)3

Not offered in 1955-1956

A continuation of PH 515. In addition to some topics in the kinetic theory of liquids and solids, the following are considered: entropy and probability, Maxwell-Boltzmann statistics, equipartition of energy, quantum statistics, and degenerate gases.

Text: Tolman, *Principles of Statistical Mechanics.*

PLASTICS

PL 301-302 **Introduction to Plastics Technology** **(3-3)(3-3)8**
Not offered in 1955-1956

History, definitions, classes, properties, and applications of plastics. Raw materials and manufacturing processes. Methods of processing plastics materials including compounding, molding, casting, extruding, laminating, fabricating, and finishing. Evaluation and development of typical plastics problems. Laboratory instruction in the processing and fabrication of plastics materials.

PL 401-402 **Advanced Plastics Technology** **(3-6)(3-6)10**
Not offered in 1955-1956
[PL 301-302]

Applications of plastics as engineering materials. Study of important engineering properties, such as strength, flow, and resistance to chemicals, moisture, abrasion. Product, equipment and mold design. Correlation of composition, processing and fabricating with product design and applications. Continuation of laboratory instruction in processing and fabricating plastics. Use of testing equipment for evaluation of materials and end items. Standard A.S.T.M. tests for mechanical, thermal, electrical, and optical properties.

PL 411-412 **Plastics Seminar** **(1-0)(1-0)2**
Not offered in 1955-1956

Informal discussions of topics in, or related to, plastics engineering based on literature study conducted by the individual.

TEXTILES

TE 109 — Introduction to Woven Structure — (2-1)2

Fabric terminology, yarn numbering systems, principles of the loom, and basic weaves and their derivatives.

TE 201-202 — Textile Fibers — (4-0)(3-0)7

A study of the important textile fibers, both natural and man-made. Classifications, origins, production, grading, marketing, and consumption. Stress is placed on their basic physical and chemical properties and their relationship to processing and utilization.

TE 203 — Textile Fibers — (4-0)4

Similar to TE 201-202, but less detailed.

TE 204 — Yarn Manufacture — (3-6)5

[TE 201]

The fundamental theory and practice of yarn manufacture by the cotton, woolen, worsted, and filament systems.

TE 206 — Yarn Manufacture — (3-3)4

[TE 203]

Similar to TE 204, but less detailed. Laboratory work consists of demonstrations only.

TE 273 — Surface Design Fundamentals — (0-2)1

Fundamentals of surface design presented to develop an understanding of various surface patterns and rhythms for pleasing distribution of line and form.

TE 274 — Applied Decorative Design — (0-2)1

[TE 273]

Application of the fundamentals learned in TE 273 toward creation of surface patterns for prints and Jacquards.

TE 281-282 — Fashion Illustration — (0-3)(0-3)2

Illustration of garments on typical fashion figures, depicting all types of fabrics of various weights and textures.

TE 300 — Fabrics — (2-0)2

[TE 109 or permission of instructor]

This subject is designed to acquaint the student with many of the important fabric types in use today for wearing apparel, home furnishings, and industrial uses. An analytical discussion is used

so that the student may not only identify the fabrics but also understand the significance of the weave, design, yarns, etc., used.

TE 301-302 — Yarn Manufacture — (5-12)(3-6)14

[TE 204]

Not offered in 1955-1956

A continuation of TE 204.

TE 303-304 — Fabric Manufacture — (1-3)(2-3)5

[TE 204, and TE 301-302 taken concurrently]

Not offered in 1955-1956

The fundamental theory and practice relating to the design, construction and analysis of commercial fabrics, regardless of the fibers and/or yarns involved. Weaving and knitting, with their allied processing operations.

TE 305 — Elements of Textile Manufacture — (3-3)4

Not offered in 1955-1956

Similar to TE 327-328, but less detailed.

TE 307-308 — Yarn Manufacture — (3-3)(3-3)8

[TE 206]

Not offered in 1955-1956

A continuation of TE 206.

TE 309-310 — Fabric Manufacture — (2-2)(3-3)6

[TE 203, and TE 307-308 taken concurrently]

Not offered in 1955-1956

An abbreviated version of TE 303-304 and TE 401-402. Laboratory work consists of demonstrations only.

TE 311 — Handloom Weaving — (0-3)1

Not offered in 1955-1956

The handloom is used as the means of producing in a minimum amount of time many different fabric constructions, utilizing yarn of different diameters, types and color.

TE 312 — Structure and Properties of Synthetic Fibers — (3-0)3

[CH 202 and PH 201]

The fundamental structure and properties of the manufactured fibers. The material is developed with the aim to relate the structures of the fibers to their properties and to lay the foundation for the more advanced work covered in TE 427-428.

TE 313-314 — Cotton Spinning — (2-3)(2-3)6

[Permission of instructor]

A continuation of the study of yarn manufacture, covering the many types of regular and long draft spinning, spooling, winding

and twisting machines and their products—plain and fancy yarns, threads, cords and ropes. Particular consideration is given to the production of yarns for different uses and to methods by which desired characteristics may be obtained. All the calculations regarding yarns, spinning frames, spoolers, winders, and twisters are thoroughly studied and problems are assigned for student practice. In the laboratory, standard industrial machinery is used to process fibers such as are commonly used in cotton mills.

TE 315-316 **Woolen Yarns** (2-4)(2-4)6

[Permission of instructor]

Woolen system fiber blending, oiling, picking, carding, spinning, twisting, and the handling of reused and reprocessed fiber. Old rags and new clips are graded and sorted. Rag sources are covered as are rag picking, lumping, shredding, garnetting and complete manipulation from reprocessed clips and waste to fiber ready for carding and making into yarn. The processing of wool and synthetic fiber is studied in theory and practice. Special emphasis is given to details of woolen machinery, such as tape and ring doffer type condensers, broadband and Apperly intermediate feeds, automatic weighing feeders, peralta rolls, card drives, and modern mule and ring spinning.

TE 317 **Staple Fiber Manufacture** (1-2)2

[Permission of instructor]

Methods of manufacture of various staple fibers, such as wool, rayon, or the new synthetics, on regular or modified cotton machinery. Special attention to new developments.

TE 318 **Cotton Quality Control** (1-2)2

[Permission of instructor]

While it is customary to point out defects in the materials during the processing in all the lecture and laboratory work, this subject provides a logical summary of the usual defects which appear in different stages of cotton manufacture. The student is taught to recognize defective work and is given the usual causes of the common defects. The usual procedures and methods necessary to avoid or correct the defects are explained. Many samples of defects are used to illustrate this subject. Every effort is made to develop the diagnostic ability of the student so that he may readily recognize and remedy defects as he meets them.

TE 319 **History of Costume and Adaptions** (1-2)2

Not offered in 1955-1956

A general coverage of typical costume through the ages from the early Egyptian to the present. The student is expected to make many modern adaptions inspired by period costumes.

TE 320 **Throwing Plant Organization** **(2-0)2**

[Permission of instructor]

Plant organization, processing procedures, and quality control. Plant layouts from machinery viewpoints are discussed and assigned for study. Field trips to local plants are an integrated part of the class work.

TE 321-322 **Worsted Yarns** **(3-5)(3-3)9**

[Permission of instructor]

Advanced gilling; French combing; top analysis and stapling; worsted yarn manufacture, including drawing, spinning, and twisting for both the English and French systems; colored blending of dyed wool tops, also blending wool top with other fibers. Gilling theories are demonstrated; French combing wool is processed into top on the French comb and both French and English system yarns are manufactured. Experiments are run on super draft drawing and spinning frames.

Much new equipment is available for laboratory work, as Whitin Super Draft Rover; Saco-Lowell FS-4 Rover and SS4 Spinning Frame; Whitin French Spinning Frame; six operation set French Drawing, etc.

TE 323-324 **Color** **(1-1)(1-1)2**

Not offered in 1955-1956

A study of color, value and chroma using the Munsell color system. Several plates painted by the student show the application of color to textiles. These plates include perfected harmony and distribution in patterns illustrating stripes, checks, plaids, and decorative designs. The influence of colors upon one another is stressed.

TE 326 **Cotton and Synthetic Design** **(1-2)2**

Not offered in 1955-1956

Analysis and construction of cotton and synthetic fabrics.

TE 327-328 **Elements of Textile Manufacture** **(3-3)(3-3)8**

Not offered in 1955-1956

The elements of fiber preparation, yarn manufacture by all systems, weaving, and knitting. Laboratory consists of demonstrations only.

TE 352 **Fabric Draping** **(0-3)1**

The application of fabric to form for the purpose of understanding fully the use and limitations of various fabrics used in garments.

TE 401-402 **Fabric Manufacture** (4-6)(5-9)14

[TE 304]

Not offered in 1955-1956

A continuation of TE 303-304.

TE 403-404 **Textile Evaluation** (2-2)(2-2)6

[CH 102 and MA 102]

Not offered in 1955-1956

This subject is designed to provide a foundation for more advanced work in testing, and is of sufficient breadth to benefit those students whose main need is an understanding and appreciation of the scope of testing and evaluation in the textile industry. The subject matter covers an applied approach to the statistical treatment of experimental data, and the basic mechanical or physical, chemical, and optical tools and techniques available to the industry for product control, development, and evaluation. Primary emphasis is placed upon an understanding of the principles involved and an integration of the various phases of textile testing into a unified whole.

TE 405-406 **Textile Finishing** (2-3)(2-3)6

[CH 302 and TE 304 or 310]

Not offered in 1955-1956

Lectures and pilot plant laboratory work in all major physical and chemical operations necessary for the conversion into the finished state of all fabrics commonly used, regardless of fiber content.

TE 407 **Knitting** (2-3)3

[EN 102 and 112]

Similar to TE 419, but with less laboratory work.

TE 408 **Cotton and Synthetic Finishing** (3-3)4

[CH 202 and TE 300]

Similar to TE 421, but stressing the chemical, rather than the physical, aspects.

TE 409 **Woolen and Worsted Finishing** (3-3)4

[CH 102 or 104]

An abbreviated version of TE 423-424.

TE 411-412 **Jacquard Design and Weaving** (1-2)(1-2)4

[Permission of instructor]

Weaving on the Jacquard loom and the various tie-ups in common use. Instruction includes the sketching of original designs as applied to particular fabrics. The student is taught to transfer his original sketch to cross section design paper, to choose the proper weave for both the background and foreground, to cut cards and lace, and to weave the fabric.

TE 413 or 414 **Jacquard Design** **(0-2)1**
[Permission of instructor]

The student is taught to transfer a given motif to cross section paper, to choose the proper weave for the background and the foreground, and complete a Jacquard design. A sufficient number ot cards are cut and laced to enable the student to appreciate the complete operation from the motif to the loom.

TE 415 **Woolen and Worsted Mill Organization** **(4-0)4**
[TE 316 and 322]

A recapitulation of the routine covered in previous wool textile manufacturing subjects. Mill layouts are organized to make definite yardages of specific fabrics using modern machinery by both the woolen and worsted systems of manufacture.

TE 417 **Cotton Mill Organization** **(4-0)4**
[TE 314]

This subject correlates all of the work on cotton manufacturing. Starting with a study of actual mill organizations the class is carried forward to problems in developing new organizations for specific types of products. The adaptations for long draft and for the handling of staple fibers are carefully covered. Calculations are made for the machinery necessary to keep plants in balance with some consideration of the best arrangements for economical handling.

TE 418 **Management Problems** **(2-0)2**
[TE 417]

Supplementary to TE 417. Job descriptions, job assignments and work load studies. Some time is spent considering arrangement of machinery for practical routing and operation, auxiliary equipment necessary and materials handling problems for efficient manufacturing.

TE 419 **Knitting** **(2-5)4**
[Permission of instructor]

A broad survey of the important types of knitting. Considerable stress is placed on the various stitches and the characteristics of fabrics from each. Starting with flat machines, the work advances through small ribbers, automatic hosiery machines, full-fashioned hosiery machines, underwear machines and warp knitters. The production, design, and analysis of knit fabrics and the classifications and routines for manufacture of hosiery and underwear are included.

TE 421 **Cotton and Synthetic Finishing** **(3-3)4**
[CH 302, TE 300]

All the major physical and chemical operations necessary for the conversion into the finished state of staple gray cotton and syn-

thetic fabrics are considered. In addition to inspection, singeing, desizing, padding, drying, calendering, curing, etc., the preliminary wet processing operations through dyeing are illustrated. Among the types of finishes employed are those of starching, softening, repelling, stabilizing, decating, etc., as well as the thermo-plastic and thermo-setting resins. The physical, rather than the chemical, aspects are stressed.

TE 422 Advanced Textile Design and Analysis (2-1)2
[Permission of instructor]

The first half of the semester is devoted to the study of Leavers Lace including history, manufacture, finishing, a detailed study of the Leavers machine, and the basic principles of lace design and drafting. The second half of the semester covers a study of embroideries and rugs. Schiffli embroidery includes the Schiffli machine, basic principles of Schiffli design, manufacturing, finishing and types and end uses of embroidery. Rugs include a study of the principles of construction and the analyses of Chenille, Wilton, Brussels, Tapestry, Velvet and Axminster carpets.

TE 423-424 Woolen and Worsted Finishing (2-3)(2-3)6
[CH 102]

A comprehensive introduction and orientation to the physical, rather than chemical, aspects of finishing including burling and mending, fulling, washing and speck dyeing, carbonizing, gigging, napping, steaming, singeing, crabbing, brushing, shearing, and pressing.

TE 426 Advanced Knitting (2-5)4
[TE 419]

This is an advanced subject for students who are specializing in knitting. With the approval of the department head, the student may select a particular field from the various sections of the knitting industry and concentrate on its problems.

TE 427-428 Properties and Applications of Synthetic Fibers (3-0)(3-0)6
[TE 312]

A continuation of TE 312. Much of the time will be spent on consideration of the fundamental properties of man-made fibers in relation to each other and to the behaviors of the finished textile resulting from these basic properties and the geometry imposed upon the fibers in the textile. To make the material more useful, comparisons are made with natural fibers and their textiles. Recent advances in the manufacture and study of fibers will be discussed.

TE 431 or 432 **Advanced Weaving** **(2-3)3**
[Permission of instructor]

Advanced work on the Crompton & Knowles looms, including the overhead multiplier, the filling mixer, and the tri-color automatic loom. Advanced work on the dobby looms, including Leno and Terry attachments. Other advanced areas such as Jacquard heads, harness mounting problems, and carpet weaving are also covered.

TE 433 **Pattern Drafting** **(0-3)1**

Methods of determining the parts of a pattern which form a basic plan for cutting a garment. Variations from the basic pattern are developed to show how changes occur.

TE 435 **Woolen and Worsted Design** **(1-2)2**
Not offered in 1955-1956

Analysis and construction of woolen and worsted fabrics.

TE 437 **Weaving Laboratory** **(0-3)1**
Not offered in 1955-1956

Application of theories learned in textile manufacturing classes.

TE 442 **Fashion Design and Construction** **(1-4)2**

Students are expected to originate and execute modern fashion silhouettes, by means of progressive steps, from drawing, through drafting, to the finished garment.

TE 444 **Jacquard Design** **(1-2)2**

Instruction includes work on original sketch, transfer to cross section paper, and indication of weave for background and foreground, in order to cut cards and lace for the Jacquard loom.

TE 501 or 502 **Methods of Research** **(2-0)2**

A seminar to familiarize the student with the philosophy and methods of research, current problems in textile research and the further use of textile literature.

TE 590-591 **Thesis Research** **Credits and hours to be arranged**

DEGREES CONFERRED IN 1954

Bachelor of Science

Robert Appelbaum
Surendra P. Asher
David Irving Austin
Marvin Arthur Baevsky
Gerald Elliot Berlyn
Harry Berman
Edward Louis Bonacci
Daniel Lewis Brier
George Joseph Broderick, Jr.
William S. Brown
†Charles Luther Cashin, Jr.
Robert Thomas Cassidy
Edward James Collins
William Eugene Dooley
Russell Paul Doyle
Jean-Charles DuCharme
Robert Joseph Fisher
Kenneth Allan French
Robert F. Fulton
†William George Gabriel
†Albert Joseph Genereux
‡Jerome Herbert Gilmore
Edward Arthur Glasheen
Edward Lucian Golec
Lincoln Hovey Good
Ernst Gottschalk
Kenneth Barnes Hallas
Donald Baker Hanson
Harry Haralampopoulos
Charles James Higgins
Herbert Jack Hodus
‡I. Laurence Hunter
Joseph L. Iannazzi
Victor Te-Chang Kao
Michael Bondy Kaye
‡William James Kennedy, Jr.
Ernest Joseph Khoury
Arnold Lawrence Kimmell
Georgina Betty Kinney
Melvin Charles Kleeman
Robert Wayne Legge
†Arthur Joseph Libbey, Jr.
Robert John Lorman
Dan Camil Manuila
Albert Joseph Marchand
‡Othon John Mavro
Paul M. McDonagh
†Donald Stanley Nichols
James Francis O'Sullivan
Raymond Peter Pecci
†Andre Joseph Pelletier
†Robert Joseph Pelliccione
Thomas Stephen Quealy
†William John Reardon, Jr.
Walter Archibald Robbins, Jr.
Cesar Augusto Robelo
Donald Francis Rogers
Warren Stanley Rushton
‡Sidney Sands
Thomas Joseph Sargent
Othello Scarponi
Gerald Howard Siegel
†Charles Augustus Smith
Abby Dolber Steinsapir
Charles Frank Sturm
Kenneth Elliott Tanzer
†Arthur Tournas
**‡Donald Thomas Wark
Abram Weiser
Florian Julius Weissenborn
Lloyd Elmore Whitney, Jr.
John Stewart Wilkinson
†Edwin Walter Zale

†Awarded Certificates of Completion for successfully accomplishing all requirements of AFROTC training.
‡Commissioned Second Lieutenant in the United States Air Force Reserve.
**Distinguished Military Graduate.

Bachelor of Science with Honors

†*Stephen Emil Adler
*Ronald Ainsworth Cohen
*Melvin Walter Ettenson
†*Thomas Francis Garvey
†*Armand Lawrence Greenhall, Jr.
‡*Henry Ronald Hamilton
*Raymond Lucien Hebert
*William Kyros
*‡**Tristan Arnold Laurion
†*Bernard Alan Leventhal
†*Charles Philip Riley, Jr.
†*Robert Frank Smith
†*Robert Evan Swift
†*Robert William Waugh
*Harry Norman Woessner

Bachelor of Science with High Honors

*Harry Edwin Flint
*Bernardo Kupferschmid
*John Rowen Reilly, Jr.

Bachelor of Science with Highest Honors

*Alan C. Cate

Master of Science

Athanasios P. Anninos
Textile Chemistry
B.A., Bowdoin College, 1951

Leo Barish
Textile Chemistry
B.S., New Bedford Institute of Textiles and Technology, 1952

Herman Brown
Textile Chemistry
B.S., Northeastern University, 1947

†Awarded Certificates of Completion for successfully accomplishing all requirements of AFROTC training.
‡Commissioned Second Lieutenant in the United States Air Force Reserve.
**Distinguished Military Graduate.
*Tau Epsilon Sigma (*Textile Scholastic Society*)

BOARD OF TRUSTEES

ADMINISTRATION

President
Martin J. Lydon, A.B., A.M., Sc.D.
Montview Road, Chelmsford

Dean of Faculty
Charles F. Edlund, S.B., Ed.M.
68 Baldwin Street, Lowell

Assistant to the President
Everett V. Olsen
2 Main Street, North Chelmsford

Director of Evening Division
Charles L. Daley, B.T.C.
465 Pine Street, Lowell

Assistant Director of Evening Division
Robert J. Peirent, B.S., M.S.
663 Hildreth Street, Dracut

Bursar
Wallace C. Butterfield, B.S.
13 Sylvan Avenue, Chelmsford

Registrar
Walter M. Drohan, A.B., A.M.
85 Nelson Street, Winchester

Records Clerk
Lorraine I. LeDoux
43 Plymouth Street, Lowell

CALENDAR — 1955-1956

First Semester

September 12, 13, 20, 1955, 7-8:30 P.M.	Registration
September 26, 1955, Monday	Classes begin
October 10, 1955, Monday	Columbus Day, Holiday
November 23, 24, 1955, Wednesday & Thursday	Thanksgiving Recess
December 19, 1955, Monday	Christmas Recess begins
January 3, 1956, Tuesday	Classes resume
January 19, 1956, Thursday	End of First Semester

Second Semester

January 17, 18, 19, 1956, 7-8:30	Registration
January 30, 1956	Classes begin
February 22, 1956, Wednesday	Washington's Birthday, Holiday
April 2, 1956, Monday	Easter Recess begins
April 9, 1956, Monday	Classes resume
April 19, 1956, Thursday	Patriots' Day, Holiday
May 17, 1956, Thursday	End of Second Semester

GENERAL INFORMATION

Entrance Requirements

Entrance requirements vary with the subject selected. For subjects taken toward a certificate, the requirement, in general, is graduation from grammar school or presentation of equivalent education. For subjects taken for college credit, the requirement is graduation from a recognized high school or presentation of equivalent study or achievement.

Evidence of equivalent education, in place of grammar or high school graduation, may be given by taking an examination, usually on registration evenings, or by presenting records of various courses taken elsewhere.

Registration

Students must register by filling out the necessary forms and paying fees before attending classes. Registration is held on the dates indicated in the calendar on the preceding page or on the opening nights of the various classes. Much time will be saved by registering on the evenings set aside for that purpose.

Sessions

Classes are held on Monday, Tuesday, Wednesday and Thursday evenings each week, usually from 7 to 9 P.M., although other hours are sometimes required in particular subjects. The subjects offered require from one evening per week to three evenings per week. (See subject schedules.)

The scheduled nights for the various subjects in the following pages are tentative and may be altered in a few cases.

Fees and Deposits

A registration fee of one dollar per semester is required of *all* students, in addition to tuition and other charges.

Tuition for subjects not offering college credit is free to residents of Lowell, but non-residents will be charged as follows per semester:

Subjects meeting one evening per week	$5
Subjects meeting two evenings per week	$10
Subjects meeting three evenings per week	$15

To receive free tuition, residents of Lowell must file a certificate of residence with the Registrar. These certificates may be obtained from the Election Commission, City Hall, Lowell. However, registration may be completed prior to filing this certificate.

All students taking subjects for college credit will be charged $9 per credit to a maximum of $25. However, college-level subjects may be taken without college credit at the rate charged for non-credit courses.

Students electing any chemistry course that requires laboratory work must pay a laboratory fee of $10 per semester in addition to their tuition. Those electing Machine Shop Practice must pay a laboratory fee of $5 per semester in addition to tuition. These fees are to cover supplies and normal breakage. Any excessive breakage will be billed directly to the student and must be paid before credit can be obtained for the course. No portion of these laboratory fees will be returned except as provided in the section on refunds. These laboratory fee requirements apply to *all* students registering in these courses whether they are residents or non-residents of Lowell.

Regularly enrolled day school students at the Lowell Technological Institute may take evening courses, except for college credit, without charge for tuition but must pay the one dollar registration fee and the laboratory fee where the latter is required.

All fees must be paid in full at the time of registration.

Refunds

Students dropping out of a course any time before the end of the first five weeks of the semester may obtain a refund of one-half their tuition and one-half of any laboratory fee paid, *provided application for such refund is made prior to the expiration of the first five weeks.* No refunds of any kind will be made after the first five weeks. The registration fee of one dollar will not be returned in any case unless the course is cancelled.

Late Registration

No new registrations or course changes will be accepted for any course after the first three weeks of classes have been held in that course.

Veterans

All L.T.I. Evening Division courses are approved for study under the G.I. Bill of Rights. World War II Veterans currently in training who have remaining educational entitlement may complete their program subject to VA regulations. Korean Veterans should make application for educational benefits at their Veterans Administration Office and secure a certificate of eligibility before registering. However, Korean Veterans will be required to pay the full tuition and registration fee at the time of registration.

Books and Supplies

Students must provide their own books, paper, drawing materials, etc., and pay for any breakage or damage of school equipment that they may cause.

Student supplies will be sold by the school cooperative store each evening school night from 6:45 to 8:15 P.M.

Size of Classes

No first year course will be given unless at least 10 men register for it and, in a few instances, more than that number. Advanced courses will usually, but not necessarily, be given, regardless of number.

Inclement Weather

Due to difficulties in notifying in time students and instructors who reside at a distance, evening school will not be cancelled for reasons of weather at any time.

Attendance

Students must attend 70% of all classes held in a course in order to receive credit for the course. Four unexplained absences in a row will result in the student being automatically dropped from the rolls.

Credits

Subjects considered of college level are indicated in the subject descriptions and credit hours are assigned to them. A high-school diploma is a prerequisite for all college-level courses.

Diplomas

Diplomas will not be offered to new students. However, students who indicate that they are already working toward a diploma under previous provisions will be allowed to continue their course and, if they successfully complete the requirements thereof prior to June, 1958, will be granted their diploma. Such students should inform the Registrar of their intentions at the time of registration.

Certificates

Certificates will be awarded for the satisfactory completion of each semester subject except that in the following courses a certificate can be earned only by passing all subjects listed after each course.

Architectural Drawing E-13A, B, E, and F

College Chemistry C-33 and C-34

College Quantitative Analysis C-36 and C-37

Cotton Design M-27, M-28, and M-51

Cotton Yarns M-11, M-12, M-13, and M-14

Electrical Circuits E-44 and E-45

General Chemistry C-31 and C-32

Leather Technology E-62 and E-63

Machine Shop Practice E-14 and E-15

Mechanical Drawing E-13A, B, C, and D

Physical Chemistry C-21 and C-22

Practical Leather Chemistry E-60 and E-61

Pulp and Paper Technology E-1 and E-2

Textile Chemistry and Dyeing C-23, C-24, C-25, and C-26

Woolen and Worsted Design M-29, M-30, and M-51

CHEMISTRY

Prof. George R. Griffin, B.S., M.A., Ph.D., *Chairman of Division*
Prof. William G. Chace, Ph.B., M.S.
Assoc. Prof. Charles L. Daley, B.T.C.
Assoc. Prof. Charles L. Howarth, B.T.C.
Assoc. Prof. Ernest P. James, B.T.C., M.S.
Assoc. Prof. Allen Scattergood, A.B., Ph.D.
Asst. Prof. Charles A. Everett, B.T.C.
Asst. Prof. Vasilis Lavrakas, B.S., M.S.
Asst. Prof. Walter J. Lisien, B.T.C.
Asst. Prof. Robert J. Peirent, B.S., M.S.
Mr. Ray E. MacAusland, Instructor, L.T.I.

First Semester Subjects (Sept.-Jan.)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
College Chemistry	C-33	Mon., Tues. & Thurs.	C-32
College Quantitative Analysis	C-36	Mon., Tues. & Thurs.	C-35
General Chemistry	C-31	Mon., Tues. & Thurs.	None
Organic Chemistry	C-38	Mon. & Thurs.	C-34
Physical Chemistry	C-21	Tues. & Thurs.	C-37
Qualitative Analysis	C-35	Mon., Tues. & Thurs.	C-34
Quantitative Analysis	C-41	Mon., Tues. & Thurs.	C-35
Textile Chemistry & Dyeing	C-23	Mon., Tues. & Thurs.	C-39
Textile Chemistry & Dyeing	C-25	Mon., Tues. & Thurs.	C-24

Second Semester Subjects (Jan.-May)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
College Chemistry	C-34	Mon., Tues. & Thurs.	C-33
College Quantitative Analysis	C-37	Mon., Tues. & Thurs.	C-36
General Chemistry	C-32	Mon., Tues. & Thurs.	C-31
Physical Chemistry	C-22	Tues. & Thurs.	C-21
Technology of Fibers	C-39	Tues. & Thurs.	C-38
Textile Chemistry & Dyeing	C-24	Mon., Tues. & Thurs.	C-23
Textile Chemistry & Dyeing	C-26	Mon., Tues. & Thurs.	C-25
Textile Quantitative Analysis	C-42	Mon., Tues. & Thurs.	C-41

Subject Descriptions

C-21 and C-22 Physical Chemistry. This subject is designed for those in the laboratory or industry. It includes a discussion of properties of gases, liquids, solids, and solutions; chemical equilibrium, phase equilibrium, thermochemistry, electrochemistry, and other topics according to the need of the students. Laboratory work is assigned as required to give the student practice in the methods and apparatus of Physical Chemistry. Laboratory work includes the measurement of vapor pressure, viscosity, surface tension, heat of combustion and reaction, conductivity, determination of molecular weight, pH by various methods, etc. The first semester is largely lectures and the second is mostly laboratory. College credit (except for chemistry majors): C-21—4 credit hours; C-22—1 credit hour.

C-23, C-24, C-25, C-26 Textile Chemistry and Dyeing. The action of chemical reagents on the natural and synthetic fibers; the preparation of fibers for dyeing; the application of all classes of dyes to cotton, wool, silk, synthetic and union materials; and the testing techniques involved in measuring fastness to light, washing, crocking, perspiration, etc. One lecture, 7-9 P.M., and two laboratories, 7-9 P.M., per week.

C-31 and C-32 General Chemistry. Two semesters of basic Inorganic Chemistry for those with no previous knowledge of Chemistry. The fundamental laws of Chemistry; the preparation, properties and uses of metals, non-metals and related compounds; and simple chemical calculations. Two lectures, 7-9 P.M., and one laboratory, 6:30-9:30 P.M., per week.

C-33 and C-34 College Chemistry. Two semesters of Inorganic Chemistry, open to those who have passed C-32 or a satisfactory course in high school Chemistry. Two lectures, 7-9 P.M., and one laboratory, 6:30-9:30 P.M., per week. College level; 5 credit hours per semester.

C-35 Qualitative Analysis. The systematic analysis of inorganic compounds, carried out by the student in the laboratory using semi-micro technique. Chemical calculations and the balancing of chemical equations are covered in the stoichiometry portion of the course. One lecture, 7-9 P.M., and two laboratories, 6:30-9:30 P.M., per week. College level; 4 credit hours.

C-36 and C-37 College Quantitative Analysis. The basic principles of gravimetric and volumetric analysis with sufficient laboratory work to enable the student to become proficient in performing routine analysis. One lecture, 7-9 P.M., and two laboratories, 6:30-9:30 P.M., per week. College level; 4 credit hours per semester.

C-38 Organic Chemistry. A study of the important classes of carbon compounds and the fundamental theories of Organic Chemistry.

C-39 Technology of Fibers. The basic physical and chemical properties of natural and synthetic fibers.

C-41 Quantitative Analysis. One semester of quantitative analysis for those not desiring college credit in Chemistry but who wish to develop laboratory skills and techniques of a practical nature. One lecture, 7-9 P.M., and two laboratories, 6:30-9:30 P.M., per week.

C-42 Textile Quantitative Analysis. A continuation of C-41. The analysis of materials used in textile mills, dye houses and finishing plants, with emphasis on the practical techniques used in the analysis of bleaching agents, industrial water, soap, oils and synthetic detergents.

ENGINEERING

Prof. Herbert J. Ball, S.B., B.C.S., F.T.I., *Chairman of Division*

GENERAL ENGINEERING, ELECTRICITY, AND ELECTRONICS

Prof. Herbert J. Ball, S.B., B.C.S., F.T.I., in charge

Prof. Harry C. Brown, B.S.

Assoc. Prof. Maurice E. Gelinas, S.B., A.M.

Asst. Prof. J. Arthur Ainsworth, B.S., M.S.

Asst. Prof. James W. Bell

Asst. Prof. Andrew A. Ouellette, B.S.

Asst. Prof. Edward N. Sabbagh, S.B.

Mr. Stanley T. Athas, B.S., Development Engineer, Shawmut Engineering Co., Dorchester

Mr. James Armour

Mr. Edward Berly

Mr. Louis C. Block, B.S., Ed.M., Instructor, L.T.I.

Mr. Stephen J. Bodor, B.S., Instructor, L.T.I.

Mr. A. E. Brownrigg, Quality Control Engineer, Sprague Electric Co., Nashua, N. H.

Mr. Albert Carpentier, B.S.

Mr. Frank Dacey, A.B., Supervisor, Courier-Citizen Co., Lowell

Mr. Robert K. Devejian, B.S., Instructor, L.T.I.

Mr. Jack L. Fink, B.S., Design Engineer, General Electric Co., Lynn

Mr. Walter J. Grondalski, B.S., M.Ed., Biology Dept., Lowell High School, Lowell

Mr. Maurice W. Harrison, B.T.E., Quality Control Supervisor, Mass. Mohair Plush Co., Inc., Lowell

Mr. David K. Hines, B.S.M.E., Production Design Engineer, Department Head, The Calidyne Co., Winchester

Mr. Kenneth Hird, A.M.E., Mechanical Engineer, Raytheon Mfg. Co., Newton

Mr. Lawrence Hollingworth

Mr. Frederick K. Hussey, Jr., B.S., Standards Engineer, Raytheon Mfg. Co., Newton

Mr. Stuart P. Jackson, P.E., B.S.E., Supervisor, General Electric Co., Lynn

Mr. Herbert A. Kelley, Design Engineer, Charles T. Main, Inc., Boston

Mr. Thomas F. McElligott, A.B., Ed.M., Instructor, L.T.I.

Mr. Thomas Murphy, Instructor, Lowell High School, Lowell

Mr. Arthur Peters

Mr. Robert A. Prochazka

Mr. Kenneth L. Rogers, B.S., Instructor, L.T.I.

Mr. Samuel J. Sabbagh, B.S., Buyer, Independent Lock Co., Fitchburg

Mr. Charles Sadlier, Instructor, Lowell High School, Lowell

Mr. Royden Sharpe

Mr. Sidney E. Stirk, B.S., Design Engineer, Improved Machinery, Inc., Nashua, N. H.

Mr. Chester Whitney, Landscape Gardener and Florist

LEATHER ENGINEERING

Prof. Albert E. Chouinard, B.S., M.S., Ph.D., in charge

Asst. Prof. Louis W. Stearns, B.S., A.M.

Mr. G. Arthur Brown, B.S., Instructor, L.T.I.

Mr. Alfred H. Mueller, B.S., Technical Director, American Hide & Leather Co., Lowell

PAPER ENGINEERING

Prof. John Lewis, B.S., M.S., in charge

Asst. Prof. Norwood H. Keeney, B.S., M.S.

PLASTICS ENGINEERING

Prof. Russell W. Ehlers, B.S., M.S., Ph.D., in charge

Dr. George E. Murray, S.B., Ph.D., Head, Chemistry Section, Soil Fertilization Laboratory, Massachusetts Institute of Technology, Cambridge

Mr. A. C. Walker, Dewey and Almy Chemical Company

First Semester Subjects (Sept.-Jan.)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
A. C. Machinery	E-36B	Tues. & Thurs.	E-45
Architectural Drawing	E-13E	Tues. & Thurs.	E-13B
Architectural Drawing	E-13F	Tues. & Thurs.	E-13E
Blueprint Reading	E-38	Mon. & Wed.	None
Calculus & Analytic Geometry	E-48	Tues. & Thurs.	Algebra & Trig.
Electrical Circuits	E-44	Mon. & Wed.	Algebra
Electrical Circuits	E-45	Tues. & Thurs.	E-44
Electronics	E-43	Mon. & Wed.	College Math. & Physics
Fundamentals of Electronics	E-40	Tues. & Thurs.	E-45
Fundamentals of Plastics	E-51	Mon. & Wed.	None
Leather Technology	E-62	Tues. & Thurs.	None
Machine Shop Practice	E-14	Mon. & Wed.	None
Machine Shop Practice	E-15	Tues. & Thurs.	E-14
Mathematics	E-20	Mon. & Wed.	None
Mathematics	E-21	Mon. & Wed.	E-20
Mechanical Drawing	E-13A	Mon. & Wed.	None
Mechanical Drawing	E-13B	Tues. & Thurs.	E-13A
Mechanical Drawing	E-13C	Tues. & Thurs.	E-13B
Mechanical Drawing	E-13D	Tues. & Thurs.	E-13C
Mechanism	E-30	Tues. & Thurs.	None
Oil Heating	E-35	Mon. & Wed.	None
The Physical Testing of Plastics and Elastomers	E-52	Mon.	Permission of Instructor
Practical Leather Chemistry and Laboratory Technique	E-60	Mon. & Wed.	C-32, C-35, C-38
Pulp & Paper Technology	E-1	Tues.	None
Pulp & Paper Testing Laboratory	E-3	Wed.	E-1, concurrently
Quality Control	E-46	Tues. & Thurs.	See description
Shop Mathematics	E-19	Tues. & Thurs.	None
Steam	E-22	Mon. & Wed.	None
Textile Testing	E-71	Tues. & Thurs.	None

Second Semester Subjects (Jan.-May)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Advanced Paper Technology	E-2	Tues.	E-1
Air Conditioning—Heating & Ventilation	E-34	Mon. & Wed.	None
Architectural Drawing	E-13E	Tues. & Thurs.	E-13B
Architectural Drawing	E-13F	Tues. & Thurs.	E-13E
Blueprint Reading	E-38A	Mon. & Wed.	None
Calculus & Analytic Geometry	E-49	Tues. & Thurs.	E-48
The Chemistry of Plastics	E-50	Thurs.	College Chemistry through Organic
D.C. Machinery	E-36A	Mon. & Wed.	E-45
Diesel Engines	E-32	Mon. & Wed.	None
Electrical Circuits	E-44	Tues. & Thurs.	Algebra
Electrical Circuits	E-45	Mon. & Wed.	E-44
Fundamentals of Electronics	E-40	Mon. & Wed.	E-45
Geometry of Engineering Drawing	E-13G	Tues & Thurs.	E-13D or E-13F
Industrial Electronics	E-41	Tues. & Thurs.	E-40
Leather Technology	E-63	Tues. & Thurs.	E-62
Machine Shop Practice	E-14	Mon. & Wed.	None
Machine Shop Practice	E-15	Tues. & Thurs.	E-14
Mathematics	E-20	Mon. & Wed.	None
Mathematics	E-21	Mon. & Wed.	E-20
Mechanical Drawing	E-13A	Mon. & Wed.	None
Mechanical Drawing	E-13B	Tues. & Thurs.	E-13A
Mechanical Drawing	E-13C	Tues. & Thurs.	E-13B
Mechanical Drawing	E-13D	Tues. & Thurs.	E-13C
Meteorology	E-37	Mon. & Wed.	None
Physics	E-47	Tues. & Thurs.	None
Practical Leather Chemistry & Laboratory Technique	E-61	Mon. & Wed.	E-60
Principles of Radio	E-42	Mon. & Wed.	E-40
Strength of Materials	E-24	Mon. & Wed.	None
Textile Testing	E-71	Mon. & Wed.	None

Suggested Program of Studies

Recommended subjects for students interested in machine design are:

Shop Mathematics E-19
Mechanical Drawing E-13A, B, and C
Machine Shop Practice E-14 and E-15
Mechanism E-30
Strength of Materials E-24

Recommended for those interested in electronics are:

Mathematics E-20 and E-21
Electrical Circuits E-44 and E-45
Fundamentals of Electronics E-40
Industrial Electronics E-41
Electronics E-43

Recommended for those interested in electrical machinery are:

Mathematics E-20 and E-21
Electrical Circuits E-44 and E-45
D.C. Machinery E-35A
A.C. Machinery E-36B

Subject Descriptions

E-1 Pulp & Paper Technology. The basic principles of manufacture of the common papermaking pulps, followed by a study of stock preparation and paper machine operation.

E-2 Advanced Paper Technology. Details of manufacture of various papers and their conversion to a useful end product. Guest lecturers supplement the regular staff.

E-3 Pulp & Paper Testing Laboratory. Laboratory work in the physical and chemical testing of pulps and papers.

E-13A, B, C, D Mechanical Drawing. Fundamentals of engineering drawing. The first semester covers lettering, use of instruments, geometric construction, orthographic projection, multi-view and pictorial freehand drawing. The second semester includes dimensioning, auxiliary views, cross sectioning, screw threads and working drawings. The third semester offers intersections, pictorial drawings and applications to sheet metal drawings. The fourth semester covers assembly drawings from details of parts and detailing from designers' assembly drawings.

E-13E, F Architectural Drawing. The first semester covers problems of detailing and alteration such as a young draftsman might encounter in an architect's office. The second semester takes up design of a small house including floor plan, elevations, sections, details, heating, plumbing and electrical drawings, as well as cost estimates.

E-13G Geometry of Engineering Drawing. The theory of orthographic drawing and the study of space relationships of lines, planes, and solids.

E-14, E-15 Machine Shop Practice. Metal working, including bench work, lathes, grinders, planers, shapers, presses, milling machines, care of tools, tool grinding, heat treatment, forging, use of special tools, etc. The classes are limited to 25 students.

E-19 Shop Mathematics. Topics from arithmetic, algebra, and trigonometry which are most useful in drawing and machine shop practice.

E-20 Mathematics. Algebra, including addition, multiplication, subtraction, division, factoring and fractions.

E-21 Mathematics. A continuation of E-20. Some of the topics treated are: graphical representation, linear equations, radicals, quadratic equations, logarithms, slide rule, and some trigonometry.

E-22 Steam. Heat generation, transmission, and utilization. Topics covered are: heat and its measurement, use of steam tables, types of boilers, engines and turbines, boiler and engine room accessories, testing, etc. Lectures and assignments.

E-24 Strength of Materials. Tension, compression, shear, cast iron, wrought iron, steel, timber, design of bolts, tie rods, columns, boiler shells, riveted joints, beam theory, torsional stresses, shafts, etc.

E-30 Mechanism. The principles involved in the transmission of force and motion through machines and mechanical devices. Topics covered are: mechanics, accelerated motion, moments of force, pulleys, belting, gears, cams, etc.

E-32 Diesel Engines. An elementary study of Diesel engines, their operation, and maintenance. Types of Diesels, fuel oils, fuel injection systems, combustion, cooling systems, application, maintenance, etc. Lectures and assignments.

E-34 Air Conditioning — Heating & Ventilation. The principles of air conditioning covering the fundamental laws, physical properties of the atmosphere, measuring instruments, heating, cooling, humidification and dehumidification systems, air filtration, refrigeration, etc. Lectures and assignments.

E-35 Oil Heating. Fundamentals of heating systems, oil burners, controls, installation, and service.

E-36A D.C. Machinery. The theory and operation of generators, motors, power plant switchboards, etc. Industrial application of D.C. machinery, parallel operation, etc. Laboratory work covers methods of operating and testing D.C. equipment.

E-36B A.C. Machinery. Topics include: application of instruments to A.C. circuits, alternators, transformers, power plant switchboards, induction motors, synchronous motors, single phase, polyphase (delta and three phase, four wire systems), etc. Laboratory work covers operation and testing of equipment.

E-37 Meteorology. The principles of meteorology. Weather instruments and observations, physics of the air, stability of air masses, weather fronts, theory of storms, weather maps and analyses, forecasting, and climate.

E-38 Blueprint Reading. The principles of mechanical drawing, *e.g.*, projections, sections, dimensioning, etc., necessary for the understanding of blueprints.

E-38A Blueprint Reading. Similar to E-38, but with emphasis on architectural, rather than engineering, blueprints.

E-40 The Fundamentals of Electronics. Topics include: vacuum tube theory, vacuum tube applications including rectifiers, power supplies, amplifiers, classes of amplifiers, voltage gain and power amplifiers, electronic instruments, etc. Lectures and laboratory.

E-41 Industrial Electronics. The theory and operating characteristics of gas and vacuum tubes, photo-electric cells, and the thyratron. Topics covered include: amplifiers, electronic relays and timers, thyratron applications, phase shifts, inverters, rectifiers, motor and welder control, textile and other applications. Lectures and laboratory.

E-42 Principles of Radio. Audio systems, microphones, loud-speakers, radio wave propagation, antennas, transmission lines, amplitude and frequency modulation, radio transmitters, modulators, detectors, receivers, tracking and alignment, servicing instruments, etc. Lectures and laboratory.

E-43 Electronics. A more advanced treatment of the fundamentals of electronics than E-40, offered for those who have completed college mathematics and physics. Topics included are: alternating current circuits, fundamental properties of thermionic and photoelectric tubes, amplifiers, rectifiers, oscillators, coupled circuits, and filters. College level; 3 credit hours.

E-44, E-45 Electrical Circuits. The fundamentals of direct and alternating circuits. Topics include: Ohm's Law, series and parallel resistance, power, magnetic fields, inductance, capacitance, impedance, etc. Lectures and laboratory.

E-46 Quality Control. This subject deals with the quality problem in manufacturing and approaches it through the use of statistical quality control. How to determine the true accuracy of a machine or process, how to distinguish between normal and abnormal variations in any process and how to use small sample plans for inspection are examples of topics covered. Prerequisite: Approval of the instructor. Normally requires two years of college or industrial experience. Statistics is not required. The class is limited to 25 students.

E-47 Physics. Elementary physics on the high-school level. Lectures and demonstrations.

E-48, E-49 Calculus and Analytic Geometry. The first semester covers differential calculus with the necessary analytic geometry; the second semester covers integral calculus. College level; 4 credit hours per semester.

E-50 The Chemistry of Plastics. The chemical structure of high polymers and their manufacture and preparation. The chemical reactions of plastics and their physical properties in relation to their chemical structure. This subject is designed for those in the plastics industry who desire to keep abreast of modern theory or broaden their background. College level; 2 credit hours.

E-51 Fundamentals of Plastics. An introductory study for those who wish to acquire a general knowledge of plastics. Classification, description, chemical and physical properties, uses, and methods of fabrication.

E-52 The Physical Testing of Plastics and Elastomers. A discussion of the basic theory of tensile, impact, tear, stiffness (modulus), appearance and abuse tests, etc. Topics include: testing machines, calculation of results, sources of error, interpretation of data and tests of significance. Lectures and demonstrations.

E-60, E-61 Practical Leather Chemistry and Laboratory Technique. The theoretical aspects of leather production coupled with a laboratory to carry out the planning of process control, material control, and product quality control. One section will be devoted to an intensive introduction to the histology of hides and skins and histological preparations.

E-62, E-63 Leather Technology. A lecture course covering various leather processing methods.

E-71 Textile Testing. A study of the methods used in the determination of the physical properties of textiles and the interpretation of test data. Topics include: a consideration of textile fibers and their properties, testing machines, breaking strength, elongation, fabric structure, tearing strength, thickness, bursting strength, crimp, twist, regain, etc. Lectures and laboratory.

GENERAL STUDIES

Prof. John R. Robertson, A.B., A.M., *Chairman of Division*

ART

Prof. Vittoria Rosatto, B.S., in charge

Mr. George E. Bowring

Mrs. William G. Chace

Miss Margaret Donohoe

Mr. Edward W. Dooley

Mrs. William E. Kaknes

Mrs. William R. Kiernan

Mrs. Margaret A. Moriarty

Miss Antoinette W. Nault

Mr. Leo Panas

Miss Arlene C. Redmond

Mr. John F. Vaughan

ENGLISH

Prof. Lester H. Cushing, A.B., Ed.M., in charge

Mrs. A. Stephanie Delaney, B.S., Ed.M.

Miss Margaret Delaney, B.S., Ed.M., Supervisor, Boston State Teachers College, Boston

Mr. Arthur F. Haley, Jr., B.S., M.Ed., Instructor, L.T.I.

Dr. Howard K. Moore, Asst. Prof., L.T.I.

Mr. Francis K. Neilon, B.A., Ed.M., Principal, Dracut School System, Dracut

MANAGEMENT AND SOCIAL SCIENCES

Prof. John R. Robertson, A.B., A.M., in charge

Prof. Richard W. Ivers, B.A., Ed.M.

Asst. Prof. Thomas A. Malloy, A.B., M.A., Lowell State Teachers College, Lowell

Mr. Wilfrid J. Brodeur, Bookkeeper, L.T.I.

Mr. Richard K. Donahue, A.B., LL.B., Attorney at Law, Lowell

Miss Joan M. Flanagan, B.A., Ed.M., Instructor, Haverhill School System, Haverhill

Mr. George C. Hedrick, Merchandise Manager, Bon Marche Inc., Lowell

Dr. Paul V. McLaughlin, Ph.B., Ph.L., Ph.D., Instructor, Lowell High School, Lowell

Mr. Frank Maria, Personnel Director, Merrimack Manufacturing Company

Mr. Xenophon D. Michopoulos, A.B., M.A., Director of Guidance, Danvers School System

Mr. Milton Richards, Milton Richards Advertising Agency, Lowell

Mr. Charles G. Sampas, B.S., City Editor, Lowell Sun, Lowell

Mr. Anthony Valkevitch, Foreman

First Semester Subjects (Sept.-Jan.)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Accounting I	G-82	Mon. & Wed.	None
Appreciation of World Literature	G-10	Tues. & Thurs.	None
Business Law	G-78	Tues. & Thurs.	None
Contemporary World Problems	G-58	Mon. & Wed.	None
Costume Design	G-35	Tues. & Thurs.	None
English Composition	G-20	Tues. & Thurs.	None
Fashion Illustration	G-42	Tues. & Thurs.	G-13
Foremanship	G-53	Mon. & Wed.	None
Freehand Drawing	G-13	Mon. & Wed.	None
Freehand Drawing	G-13	Tues. & Thurs.	None
Great English and American Writers	G-90	Mon.	None
Industrial Psychology	G-81	Tues. & Thurs.	None
Industrial Relations	G-55	Tues. & Thurs.	None
Principles of Advertising	G-57	Tues. & Thurs.	None
Principles of Retailing	G-18	Tues. & Wed.	None
Principles of Salesmanship	G-56	Tues. & Wed.	None
Psychology	G-75	Mon. & Wed.	None
Report Writing	G-92	Mon.	None
Show Card Design	G-14	Mon. & Wed.	None
Silk Screen Printing	G-26	Tues. & Thurs.	None
Social Revolution in America	G-88	Mon.	None
Vocabulary Building	G-16	Mon. & Wed.	None
Writing for Profit	G-86	Mon. & Thurs.	None

Second Semester Subjects (Jan.-May)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Accounting II	G-83	Mon. & Wed.	G-82
Appreciation of World Literature	G-11	Tues. & Thurs.	None
Backgrounds of World Conflict	G-89	Mon.	None
Costume Design	G-36	Mon. & Wed.	G-35
Current Affairs	G-59	Mon. & Wed.	None
Delinquency and Crime	G-22	Mon. & Wed.	None
English Composition	G-21	Tues. & Thurs.	G-20 or equivalent
Freehand Drawing	G-13	Mon. & Wed.	None
Foremanship	G-53	Tues. & Thurs.	None
Life Drawing	G-40	Mon. & Wed.	G-13
Meaning and Use of Words	G-17	Mon. & Wed.	None
Pastel Drawing	G-34	Mon. & Wed.	G-13
Principles of Retailing	G-18	Tues. & Wed.	None
Principles of Salesmanship	G-56	Tues. & Wed.	None
Show Card Design	G-15	Mon. & Wed.	G-14
Techniques of Leadership	G-23	Tues. & Thurs.	None
Water Color	G-44	Tues. & Thurs.	None

Subject Descriptions

G-10, G-11 Appreciation of World Literature. Designed to increase the student's enjoyment of great literature of all types. The first semester covers American literature and its historical background; the second semester takes up British and Continental masterpieces.

G-13 Freehand Drawing. Drawing in charcoal from casts and group arrangements of still life.

G-14, G-15 Show Card Design. The preparation of commercial signs. The first semester deals largely with lettering and elementary layouts; the second semester teaches more elaborate layouts and designs executed in tempera paints.

G-16 Vocabulary Building. A subject to help the student enlarge his vocabulary and improve his understanding and choice of words. Language roots and word evolution are also studied.

G-17 The Meaning and Use of Words. The exact meaning of words and how their proper usage can lead to clear and dynamic speech.

G-18 Principles of Retailing. Stores—types, location, and organization. Merchandise—purchasing, preparing for resale, promoting, selling, advertising and displaying. Record keeping, planning, and merchandising calculations.

G-20 English Composition. The basic elements of composition, including remedial English, grammar, sentence structure, etc.

G-21 English Composition. Writing for business and social purposes. Narration, description, reports, letters, etc.

G-22 Delinquency and Crime. The study of crime as a social problem. The causes, characteristics and treatment of criminal behavior analyzed in nontechnical language.

G-23 Techniques of Leadership. Designed to aid the industrial supervisor to relate his own behavior to that of the group under his supervision. The dynamics of leadership and of the group receive primary emphasis. The concepts, values, and limitations of democratic and authoritarian leadership are treated through case studies and textual readings. Leadership as expressed through inter-personal relationships, and the resolution of social conflict both by integration and the democratic process provide the practical basis for this subject.

G-26 Silk Screen Printing. Stenciling and printing on textiles and paper with the silk screen.

G-34 Pastel Drawing. Drawing in pastel from still life group arrangements.

G-35, G-36 Costume Design. The first semester studies methods of altering a commercial garment pattern to suit the requirements of any figure. The second semester deals with the drafting of original patterns.

G-40 Life Drawing. Drawing from the live model in charcoal or in pastel. Individual and class instruction in anatomy.

G-42 Fashion Illustration. Training in fashion illustration as applied to promotion and advertising display.

G-44 Water Color. This course is designed to acquaint students with various styles and techniques of this popular medium and also to enhance their understanding of shape, form, line and texture and the rules of color harmony and contrast. Students will work from still-life groups and individual instruction will be given.

G-53 Foremanship. A study of foremanship principles and problems based on the Foremanship Management Conference Manuals of the National Foreman's Institute. It is designed to help men now acting as foremen in a more successful handling of their job and is conducted by the conference or seminar method, each man bringing in his own problems for analysis by the group. Some of the topics are: understanding people, the foreman as a leader, eliminating irritations, training workers on the job, getting along with the man above, eliminating waste, wage incentives, cost factors the foreman can control, etc.

G-55 Industrial Relations. The underlying principles of harmonious relations between employer and employee. Some of the topics covered are: company policies and the foreman, employee morale, grievances, wages, training, collective bargaining, unions, government regulations, arbitration, etc.

G-56 Principles of Salesmanship. The fundamentals of salesmanship: the psychology of selling, building a selling talk, showmanship, elements of successful selling, wholesale and retail salesmanship, etc. Lectures plus student participation.

G-57 Principles of Advertising. The fundamentals of advertising: psychology, copy writing, layout, production, testing, campaigns, etc. Lectures and assignments.

G-58 Contemporary World Problems. The present-day issues of the world—communism, nationalism, imperialism, socialism, secularism, etc.—as they pertain to the individual's intellectual, physical and emotional life in society.

G-59 Current Affairs. A study of current news relating to social problems as they pertain to the individual's intellectual, physical, and emotional life in society.

G-75 Psychology. This course covers the fundamentals of psychology with particular reference to the group relationships of the individual.

G-78 Business Law. The basic legal principles of use to people in the conduct of their everyday affairs. Topics covered include contracts, mortgages, deeds, negotiable instruments, easements, conditional sales, partnerships and corporations.

G-81 Industrial Psychology. A human relations approach to the study of the operation of basic psychological principles in industrial situations. The subject is designed for foremen and other supervisory personnel, not professional psychologists. Emphasis is placed on the relationships between worker efficiency and behavior, attitudes, fatigue, frustration, morale, motivation, etc. Some attention is given to causes of accidents and accident prevention, and to the problem of labor turnover. Selected case studies supplement text readings.

G-82, G-83 Accounting I and Accounting II. The principles of accounting. The first semester deals with the preparation and interpretation of reports and statements of financial position. The balance sheet, profit and loss statement, theory of debits and credits, ledger, etc., are covered. The second semester carries the student into payroll and tax accounting, partnership and corporate records and the basic principles of cost accounting.

G-86 Writing for Profit. Creative writing for commercial use. Stress is laid on the creation and development of ideas in journalism, feature articles, short stories, and other forms of commercial writing. Student discussion and analysis of their own writings will be a major portion of the work.

G-88 Social Revolution in America. A college level course covering the tremendous changes that have been wrought in the social and economic structure of the United States since the Revolutionary War. The changes in the social system caused by the growth of big business, labor unions, mechanization of

industry, immigration, development of the West, Civil War, boom-and-burst philosophy, political reforms and other factors are clearly traced in their impact on our social structure both past and present with projections for the future. College level; 3 credit hours.

G-89 Backgrounds of World Conflict. This course covers the political and economic pressures that built up from the Napoleonic Era to World War I resulting in the present world struggle. The Congress of Vienna, the rise of nationalism, imperialism, power politics, effects of industrialization, and other factors are traced in detail to give a clear picture of the roots and causes of the World Wars of the Twentieth Century. This is essential background for teaching current events and the problems of the world community today. College level; 3 credit hours.

G-90 Great English and American Writers. Attention is focused on six or seven major writers. Emphasis will be on discovering what these authors have to say that is of interest or importance to the general reader today. The student will have the opportunity to determine the attitude toward life of each writer, to see what gave rise to this attitude, and to evaluate it and compare it with the views of other writers considered in the course. College level; 3 credit hours.

G-92 Report Writing. A course in expository writing stressing the methods of organizing and editing technical compositions and reports. College level; 3 credit hours.

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Asst. Prof. Michael J. Koroskys, B.S., M.S.
Mr. James T. Simpson, Time Study Supervisor, Abbot Worsted Company, Graniteville

First Semester Subjects (Sept.-Jan.)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Cotton Design	M-28	Tues. & Thurs.	M-27
Cotton Yarns	M-11	Tues. & Thurs.	None
Cotton Yarns	M-13	Mon. & Wed.	M-12
Elementary Textile Design	M-51	Mon. & Wed.	None
Knitting	M-15	Tues. & Thurs.	None
Loom Fixing	M-24	Tues. & Thurs.	M-33
Power Weaving	M-33	Mon. & Wed.	None
Power Weaving and Warp Preparation	M-32	Tues. & Thurs.	None
Reprocessed and Reused Fiber Manufacture	M-3B	Mon.	M-1 (or equivalent) & M-2
Synthetic Yarn Manufacture on Woolen System	M-3C	Tues.	M-3A
Technology of Natural and Man-made Fibers	M-2	Mon. & Tues.	None
Textile Mechanism and Calculations	M-1	Thurs.	None
Top Mill Organization	M-8	Thurs.	M-4
Woolen & Worsted Design	M-30	Tues. & Thurs.	M-29
Woolen & Worsted Finishing	M-10	Mon. & Wed.	None
Worsted & Synthetic Yarn Manufacturing	M-5	Wed. & Thurs.	M-4

Second Semester Subjects (Jan.-May)

SUBJECT	NUMBER	EVENINGS	PREREQUISITE
Cotton & Synthetic Design	M-27	Mon. & Wed.	M-51
Cotton & Synthetic Finishing	M-18	Mon. & Wed.	C-38 & M-51
Cotton Yarns	M-12	Tues. & Thurs.	M-11
Synthetic Yarn Manufacture on the Cotton System	M-14	Mon. & Wed.	M-13
Tow to Top-Synthetic and Man-made Fiber	M-7	Thurs.	M-4
Wool & Staple Synthetic French Combing	M-6A	Thurs.	M-4
Wool & Staple Synthetic Top Manufacture	M-4	Mon. & Tues.	M-1 (or equivalent) & M-2
Wool & Staple Synthetic Yarn Manufacture on the French System	M-6B	Wed.	M-4
Woolen Design	M-29	Mon. & Wed.	M-51
Yarn Manufacturing by Woolen System	M-3A	Mon. & Tues.	M-1 (or equivalent) & M-2

Subject Descriptions

M-1 Textile Mechanism and Calculations. The mechanisms and mathematics required for an understanding of textile machines. Pulleys, cones, gears, levers, cranks, revolutions, surface speed, constants, ratio, proportion, formulae, slide rule, etc. Lectures and demonstrations.

M-2 Technology of Natural and Man-made Fibers. Types of sheep and wool. Wool buying, selling, grading, sorting, scouring. Other animal fibers such as mohair, alpaca, camel, vicuna, etc. Man-made fibers, such as rayon, nylon, orlon, etc. Identification, tests, uses, properties. Theory and basic principles of yarn making by all systems. Explanation of mule spinning, frame spinning, roller drawing, porcupine drawing, pressed felt manufacture, etc. Lectures and demonstrations.

M-3A Yarn Manufacturing by Woolen System. The conventional woolen yarn system of picking and blending, carding and spinning, on both the mule and frame. Machine descriptions, adjustments, settings, maintenance, and processing techniques. Lectures and demonstrations.

M-3B Reprocessed and Reused Fiber Manufacture. The sources of reclaimed fiber, the sorting of raw materials and the carbonizing of rags. Rag picking, lumping, shredding, and garnetting. The Wool Products Labeling Act. Lectures and demonstrations.

M-3C Synthetic Yarn Manufacture on the Woolen System. Problems of processing synthetic fibers into yarn on woolen system machinery. The basic properties of synthetic fibers, techniques of processing, machine set-up, and special adjustments. Lectures and demonstrations.

M-4 Wool and Staple Synthetic Top Manufacture. The manufacture of wool or man-made fibers, such as cut staple rayon or synthetics, into top using some or all of the following operations: worsted type carding, backwashing, open and intersecting gilling, Noble Combing, Warner Swasey Pin Drafters, Holdsworth Gill Reducers. Mostly lectures, but sample lots of wool or synthetic fiber or blends are usually run in the laboratory as time permits.

M-5 Worsted and Synthetic Yarn Manufacture. Yarn making of wool or synthetic fiber or blends on the modified Bradford or English type of machinery.

Roller drawing machines, worsted spinning frames, twisters and winders are studied as well as the newer short cut systems using the Warner Swasey Pin Drafter, Holdsworth Gill Reducer, etc. Other spinning systems, such as the Bird System, American System, Ambler, Saco-Lowell Draftall, Whitin Super-Draft are studied. Lectures and demonstrations, and sample lots of synthetics and wool or blends of all types of fibers are made into yarn in the laboratory when time permits. Spinning covers all phases of flyer, cap, ring, direct and centrifugal systems. Production, scheduling and routing problems are discussed with actual mill procedures as subject matter.

M-6A Wool and Staple Synthetic French Combing. The combing of shorter wools or synthetics on the so-called French Comb. Advanced intersecting gilling and blending of wool with other fibers and blends of synthetics. Mostly lectures, but modern equipment is available in the laboratory and usually small lots of wool or synthetics or blends are run.

M-6B Wool and Staple Synthetic Yarn Manufacture on the French System. The manufacture of wool or synthetics or blends into a French worsted type yarn. Intersecting gilling, open gilling with rub aprons, French or porcupine drawing. Short cut French systems using Pin Drafters and super draft porcupines, French Frame spinning, ring and mule twisting, winding. Mostly lectures, but modern laboratory equipment is available for demonstrations and running sample lots.

M-7 Tow to Top — Synthetic and Man-made Fiber. This subject covers in detail the processes and operations necessary to make top or sliver from synthetic or man-made tow. A detailed study is made of the Pacific Converter, Perlok system, Saco-Lowell Direct Spinner, etc. Mostly lectures, but sample lots are run on a Converter as time permits.

M-8 Top Mill Organization. Methods of calculating unit costs, personnel, work loads, cost of top, machinery layouts, supervisory help, production engineering. The over-all picture of an integrated woolen and worsted mill is considered to show how the top mill fits into the complete picture. The top mill is considered in detail. Lectures only.

M-10 Woolen and Worsted Finishing. The finishing of both woolen and worsted cloths. Some of the topics covered are: burling, mending, fulling, washing, speck dyeing, carbonizing, gigging, napping, steaming, brushing, shearing, and pressing. Lectures and some demonstrations.

M-11 Cotton Yarns. First semester of cotton yarn manufacture. Properties and characteristics of raw cotton; cultivating, ginning and marketing of raw cotton; mixing, opening and picking, and carding.

M-12 Cotton Yarns. Second semester of cotton yarn manufacture. Combing, drawing, regular and long draft roving.

M-13 Cotton Yarns. Third semester of cotton yarn manufacture. Spinning, spooling, winding, and twisting.

M-14 Synthetic Yarn Manufacture on the Cotton System. The processing of staple synthetic fibers on the cotton system and the modifications of cotton type equipment to handle these fibers. The lectures are supplemented with laboratory work.

M-15 Knitting. Yarns, yarn sizing, and the manufacture of knitted fabrics and garments from all types of yarn.

M-18 Cotton & Synthetic Finishing. The methods of converting both cotton and synthetic fabrics from the gray to the finished state. All the major processes of both wet and dry finishing of these fabrics are discussed, including crease resisting, stabilizing, water repelling, flame repelling, heat setting, etc.

M-24 Loom Fixing. The timing of all different motions in the loom and remedies for improper settings. Box and harness chain planning and building. Lectures and laboratory.

M-27 Cotton & Synthetic Design. Cloth analysis and design beginning with plain fabrics and leading into stripes and plaids, plus the construction, yarn denier and filament count of various synthetic cloths.

M-28 Cotton Design. The design and analysis of more elaborate cotton fabrics, such as extra warp and extra filling figured cloths, corduroys, velvets, ply fabrics, Leno fabrics, etc.

M-29 Woolen Design. Cloth analysis and design, covering blanket, bathrobing, filling reversibles, extra warp and filling backs, figured effects, double cloths, plaid backs, triple cloths and four-ply fabrics.

M-30 Woolen & Worsted Design. This subject includes the more complicated fabrics, such as chinchilla, melton, and kersey, as well as suitings. Manufacturing costs of woolen and worsted fabrics are also covered.

M-32 Power Weaving and Warp Preparation. Warp preparation in all systems as well as the Draper and Stafford automatic looms. Lectures and laboratory.

M-33 Power Weaving. The more complicated looms are studied, including dobby and Crompton & Knowles looms, as well as the Warner Swasey weaving machine. Weaving is primarily on woolen and worsted fabrics. Lectures and laboratory.

M-51 Elementary Textile Design. Weaves of all types, from the plain weave through fancy and figured weaves. Harness draft and chain are worked out for each weave. Yarn numbering for all systems, including ply and fancy yarns.

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ANALYSIS OF PAPER FILLERS BY SPECTROGRAPHIC METHODS

by

Louis C. Block*

INTRODUCTION

The presence of mineral constituents in paper samples has long been of much significance both to the paper manufacturer and the paper processor. Whether their presence may be picked up as impurities during the manufacturing processes or whether they are added to the material for specific physical effects, the nature of the constituents and the quantities involved are frequently of utmost importance.

Wet chemical methods have offered a means of detection, but the techniques involved are often indirect and tedious, and small concentrations are at times never detected. A rapid and precise means of analysis is offered by the spectrograph. The technique is the same for all metallic elements, the results are precise and accurate to as low a concentration as one part in ten million, and a permanent record is obtained. The metallic element may be precisely detected whether it exists as a pure metal or as a chemical compound.

Qualitative and quantitative analyses by spectrographic methods have been carried on for some time in the mineralogical, steel manufacture, and oil refining industries. To the best of our knowledge, these techniques have been utilized by only a few organizations in the paper industry. This paper results from investigations carried on at Lowell Technological Institute in an effort to develop specific techniques on the preparation of the paper samples for analysis and on the procedure of spectrographic analyses on the paper samples.

The investigations reported in this paper are confined only to qualitative analyses; the methods of quantitative analysis, however, with a further extension of work, could have been pursued.

Qualitative analysis by spectrographic methods utilizes the fact that when an element is burned by some electrical source until it attains an excited vaporized state, characteristic electromagnetic radiation is emitted. This radiation in the form of characteristic wavelength lines is detected by means of a sensitized photographic plate mounted in the spectrograph. By means of suitable measuring instruments, tables, and charts, these wavelength lines and their associated elements are identified.

Quantitative analysis by spectrographic methods utilizes the fact that the intensity of a specific spectral line on the photographic plate is a function of the concentration of the element in the burned sample. By the control of operating conditions and the use of proper measuring instruments, the reading of the line intensity and its associated element concentration is determined.

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*Assistant Professor in the Division of Engineering, Lowell Technological Institute, Lowell, Massachusetts. This paper was presented by Prof. Block at the annual meeting of TAPPI, the Technical Association of the Pulp & Paper Industry, Feb. 21-24, 1955 in New York City, and is published with permission of that association.

APPARATUS

The following list consists of the basic apparatus and equipment used in the preparation and analysis of the samples:

1. Baird 3-meter grating spectrograph
2. Jaco Varisource
3. Gaertner Wavelength Comparator
4. Viewing box
5. Agate mortar and pestle
6. Chainomatic balance
7. Electrode cutter
8. Blue M electric furnace
9. Eastman Type II-0 spectrographic plates
10. Photographic darkroom with standard equipment
11. Bausch & Lomb spectrum measuring magnifier

PROCEDURE

Preparation of Samples

Eight sample sheets of paper supplied by the Byron Weston Company constituted the material used in this work. A list of the filler materials loaded in each sheet was submitted with the samples.

Each sheet was cut into small strips, weighed under dry conditions in pyrex weighing bottles and then ashed in a muffle furnace at 1800° F, until all the carbon was completely driven off. A good ashing was completed in 35 to 45 minutes, depending mainly on how closely the strips were packed in the crucible.

The material was then reweighed to determine the per cent of ash based on the dry weight. The results may be seen in Table I.

The resultant ash from each sample was mixed with pure graphite powder in a one-to-one ratio and was ground in an agate mortar until a homogeneous mixture was obtained. The graphite powder not only serves as a buffer mixture, but it also improves the conduction of the electric arc through the sample.

Obtaining the Spectrogram

The mixture of the paper ash and the graphite powder was packed into a ⅛″ deep crater drilled in the tip of a carbon electrode. With this electrode as the positive pole and a pointed tip carbon electrode as the negative pole, a 5-ampere D.C. arc was struck to ignite the specimen.

The entire radiating area of the arc was focused on the entering slit of the spectrograph and the arc exposure was maintained until all the sample appeared to have been volatilized.

Under these conditions, the more volatile elements are vaporized in the initial stage while the more refractory materials fuse down to a bead at the bottom of the crater and are vaporized more slowly. Consequently, a long burning time is usually utilized while the actual exposure intensity is decreased by inserting a rotating sector disk in front of the slit at the secondary stigmatic focus. For example, if an actual burning time of 80 seconds is used and the rotating sector disk is set to a factor of ¼, the actual exposure time is 20 seconds.

A spectrographic plate was taken of the spectrum of all eight paper samples plus an iron spectrum for calibration purposes in two different wavelength regions under the following operating conditions:

Exposure Conditions

Spectral regions 2460-3875A°*; 3640-5050A°

Slit width	75 microns
Line height	2.5 mm.
Exposure time	10 seconds
Excitation source	5-ampere D.C. arc
Arc gap width	5 mm.
Sector disk	¼ factor

*1A° = 1 Angstrom Unit = 10^{-8} cm.

Photographic Processing

Emulsion	Eastman II-0	
Developing	Eastman D-19	3 minutes @ 68° F.
Stop bath	Dilute acetic acid	20 seconds
Fixing	Kodak acid fixer	10 minutes
Washing	Running water	30 minutes

Analyzing the Spectrogram

After processing and drying, the plate was ready for analysis. By using the Gaertner Microcomparator and the eyepiece magnifier, the wavelengths of the characteristic lines in the paper samples were calculated, and their associated elements were identified by referring to the suitable charts and tables. Table II lists the results of the qualitative analyses and compares them with the Byron Weston list of "known" fillers.

DISCUSSION

It should be stated that the listing of the actual fillers present in each sample was not made available to the analyst until after the spectrographic analysis was completed, thereby insuring a completely objective analysis.

The results obtained from the spectrographic qualitative analysis of the paper samples correlated highly with the reported fillers. Spectrographic analysis, being so sensitive, may often detect the presence of impurities that are picked up by the samples in the course of manufacture, and the elements so reported may not be listed in the initial fillers.

The water used in washing might well contain calcium as well as copper and iron traces and these certainly would be detected by the spectrograph. This probably was the case in the finding of a moderate amount of calcium in sample No. 1 and in sample No. 3. As a further check on sample No. 3, a separate analysis was carried out on a commercial sample of pure Dicilite, and the presence of calcium as well as silicon was positively determined.

The only other discrepancy was in the detection of a moderate amount of titanium in sample No. 8. This could have occurred by using broke containing titanium. Any trace of titanium from this source or from reused white water would certainly show up in the analysis.

The rest of the analysis showed perfect correlation with the listed fillers.

CONCLUSION

The analysis of filler content in paper samples by spectrographic methods offers many advantages over other analysis techniques. Some of these advantages are as follows:

1. The amount of paper sample required in spectrographic analysis is extremely small; a few milligrams may suffice in many cases for a complete qualitative and quantitative analysis.

2. A permanent record is obtained which may be filed and referred to any time in the future for verification purposes.

3. The nature or condition of the sample is immaterial to the analysis techniques.

4. The number of unknowns in the sample is immaterial to the analysis techniques. The results are all determined in a single operation.

5. A minimum amount of chemical preparation and handling of the sample is required.

6. Complete results of qualitative analyses can be obtained spectrographically in only a fraction of the time compared to chemical methods. Including the time expended in ashing the samples, the complete qualitative results were concluded for all eight samples in less than three hours.*

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*Spectrographic investigations have been performed since the writing of this paper whereby the paper samples were merely shredded, inserted into the electrodes, and ignited by the high voltage spark. The results of analyzing the paper directly without any prior chemical or heat preparation have shown sufficient promise to warrant further investigations along these lines.

7. Quantitative analysis, if desired, can also be performed very quickly. After the preparation of standard mixtures and working curves in the laboratory, as many as 20 analyses per hour may be completed.

8. Spectrographic analysis determines the presence and concentration of trace elements which would normally be undetected by conventional chemical methods.

In the light of all these advantages, the use of the spectrograph as an analytical tool for the paper industry should be given serious consideration. Whether the techniques are to be utilized for basic and applied research or for quality control purposes, a rapid and precise analytical procedure presents many advantages and opportunities over the present conventional methods.

TABLE I

Per Cent of Ash of Eight Paper Samples—Dry Basis

No.	Dry Weight of Sample (grams)	Weight of Ash (grams)	% Ash (dry basis)
1	2.8868	0.2416	8.36
2	4.9508	0.0187	0.38
3	4.9473	0.1339	2.71
4	4.4239	0.1374	3.12
5	4.6606	0.2235	4.80
6	3.9564	0.0963	2.44
7	3.1224	0.1155	3.71
8	2.8797	0.1032	3.58

TABLE II

Qualitative Spectrographic Analysis of Eight Samples of Paper

No.	Filler Reported	Spectrographic Results*
1	TiO_2	Ti (heavy); Ca (moderate)
2	Blank	Blank
3	TiO_2; "Dicilite"†	Ti (heavy); Ca (moderate); Si (moderate)
4	Clay	Al (heavy); Ca (heavy); Si (heavy)
5	TiO_2	Ti (heavy)
6	Hydrated Silica	Si (heavy)
7	TiO_2 Hydrated Silica	Ti (heavy); Si (heavy)
8	Clay; Calcium Silicate	Ca (heavy); Al (heavy); Si (heavy); Ti (moderate)

*The amounts of concentration were estimated from the densities of the observed spectral lines. In addition to the elements reported, small traces of iron and copper were observed in most of the samples.

†"Dicilite" is one commercial type of diatomaceous earth.

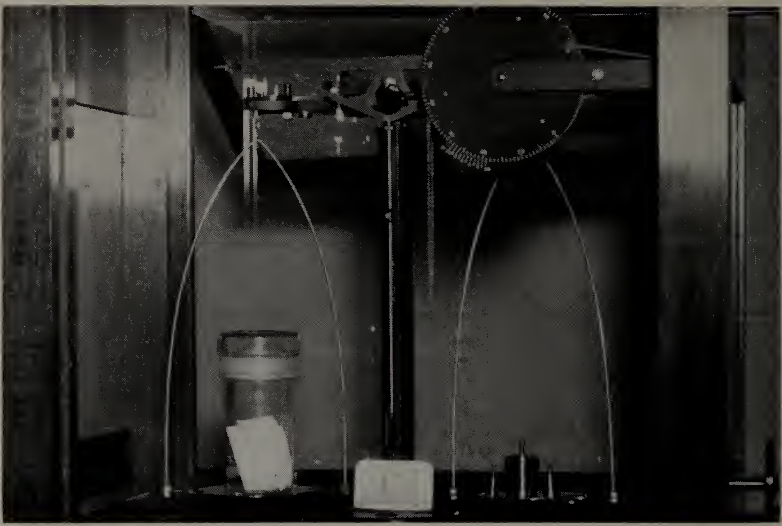

FIGURE 1

The strips of the paper sample were weighed in the pyrex weighing bottle on the chainomatic balance in a humidity-controlled weighing room.

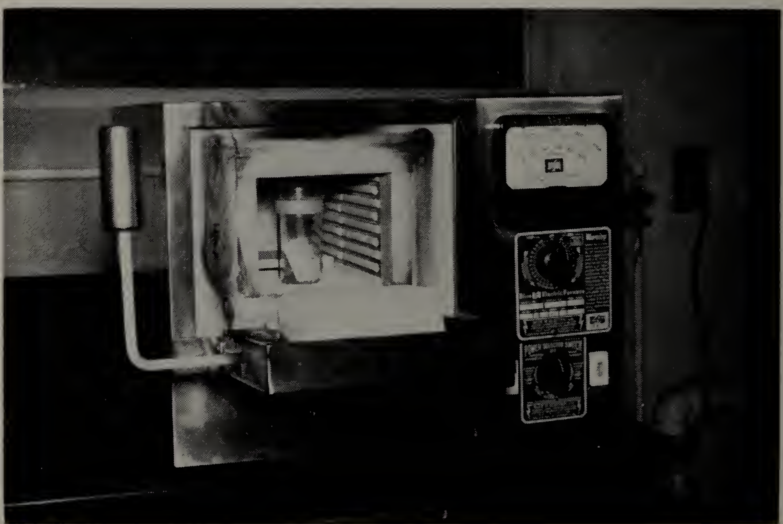

FIGURE 2

The samples, after weighing, were ashed in the electric furnace.

FIGURE 3

After ashing, the powdered samples were burned in the electric arc stand. The focusing lens and the rotating disk are to the left of the arc stand.

FIGURE 4

The Jaco Varisource unit was used to ignite the electric arc.

Figure 5

The Baird 3-meter grating spectrograph.

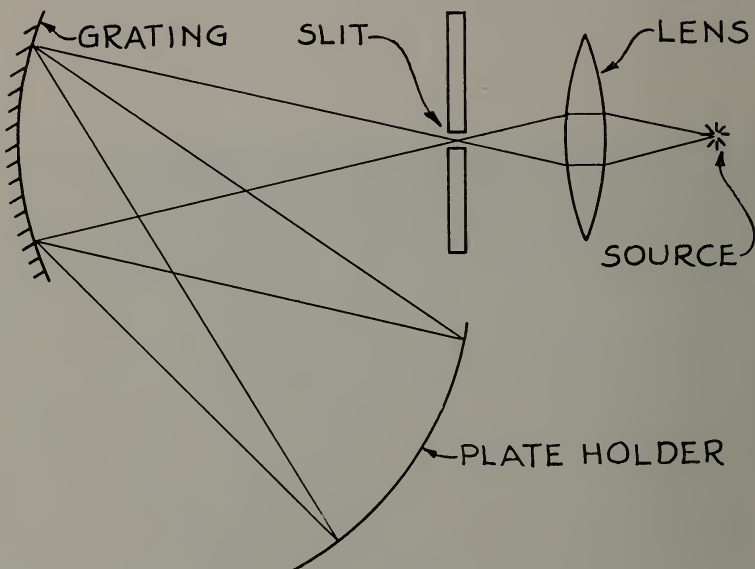

Figure 6

Schematic diagram of the optical system of the spectrograph. The radiation is focused on the slit by the focusing lens. After emerging through the slit, it is incident upon the grating. The light is diffracted by the grating into the respective characteristic wavelength radiation where it is detected by the photographic plate enclosed in the plate holder.

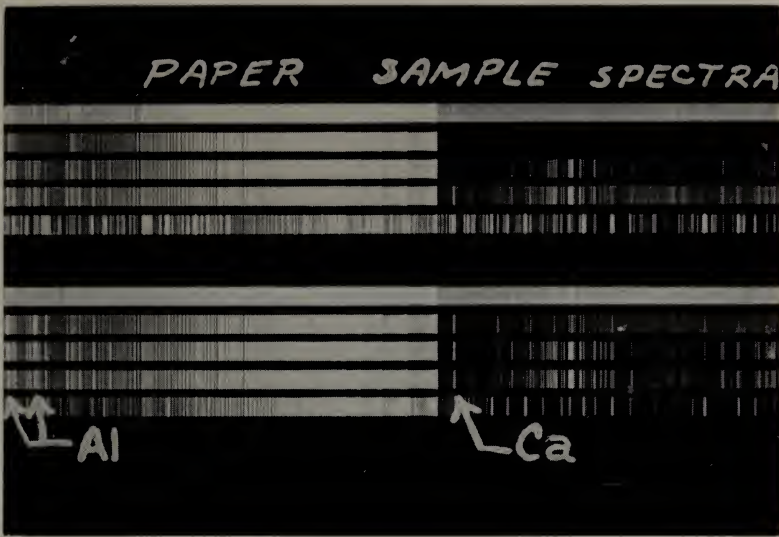

FIGURE 7

A portion of the resultant spectrogram obtained after the darkroom processing.

FIGURE 8

The measuring instruments used to determine the wavelengths of the analysis lines. The Gaertner Microcomparator is at the left. The viewing box and the eyepiece magnifier are at the right. The binocular magnifier is above the plates mounted on the viewing box.

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THE EFFECT OF CERTAIN PHYSICAL CHARACTERISTICS OF FABRICS UPON HEAT TRANSMISSION

David L. Aelion *and* Harry C. Brown*

INTRODUCTION

The following paper is an abridgement and revision of a thesis presented by David L. Aelion as a partial requirement for the degree of Master of Science in Textile Engineering at Lowell Technological Institute, Lowell, Massachusetts.

Many measurements in different laboratories have been made of the amounts of heat transmitted through textile fabrics and efforts have been made to correlate the results with such physical properties as nature of fiber content, fabric thickness, air permeability, porosity, moisture content, nature of surface, etc.

One of the first approaches to this problem was to determine whether the nature of the fiber was the major reason for the differences in heat transmission of fabrics. Chamberlain and Speakman[1] showed in their experiments with compressed loose fibers that for a given density and thickness, wool fibers had a lower conductivity than cotton, which, in turn, had a lower conductivity than viscose, though the differences were not great. They also showed that the conductivity of each type of fiber increased with an increase in density. These experiments, however, were not conclusive enough to prove that the differences in fabric insulation were mainly due to the different fibers. In a loose structure such as a textile fabric, the small difference between materials is masked by the effect of air contained in the structure.

It was obvious that other physical characteristics of fabrics were more directly responsible. It should be mentioned that in the effect of moisture, whether from body perspiration or the atmosphere, the nature of the fiber does play an important part, not because of its conductivity, but because of its moisture absorption capacity.

Because fabrics are not homogeneous structures, it is useless to determine the value of the specific conductivity of a fabric in relation to its other physical properties. Chamberlain and Speakman[1] decided that a better measure of a fabric's worth as a heat insulator would be the total heat loss, or the quantity of heat transmitted in a given time by the material when the two faces are maintained at given temperatures. They decided that the total heat loss was a function of at least three variables of the fabrics, the density, the thickness, and the nature of the constituent fiber. They have found it possible to express the warmth of all-wool fabrics by means of a general equation:

$$\frac{1}{H} = 16 + (801 - 639D)\ d$$

H = heat loss, in cal./(sec.)(sq. cm.)(15°C.)
D = density in g./cc.
d = thickness in cm.

Marsh[2], in his paper, gives an extensive review of the different experimental methods used up to that time to determine the heat transmission of fabrics. He introduced a new quantity depending only on the heat lost by the uncovered heater and the heat lost when covered by the fabric in a definite specified way; he called the quantity the thermal insulating value, T.I.V.

$$\text{T.I.V.} = \left(1 - \frac{\text{Heat lost by covered heater}}{\text{Heat lost by uncovered heater}}\right) \times 100$$

*David L. Aelion, Graduate Student, Lowell Technological Institute, 1952-53; Harry C. Brown, Chairman, Division of Engineering, Lowell Technological Institute.

e.g., if the heat loss were the same with or without the fabric, the T.I.V. would be zero, but if no heat were lost the value would be 100.

Marsh also remarked that some thin fabrics placed directly on the heater cause a greater emission of heat than the bare cylinder, and in that case the T.I.V. is negative. The effect of different tensions in the fabric when placed on the heating cylinder was clearly established.

Marsh found an almost linear relationship with a plot of T.I.V. against thickness and concluded that the characteristic which determines the T.I.V. of a fabric is its thickness, the thickness excluding the projecting fibers. No direct relationship between weight/unit area and T.I.V. was found; also, no definite relationship was found to exist between T.I.V. and density at given weight/unit area.

Black and Matthew[3] came to some interesting conclusions when they decided to analyze the structure of the fabric more closely in terms of the porosity of yarn and cloth. They based their analysis on the experimental results of Rood[4] and plotted the relationship of porosity, apparent density, weight and thickness against the heat flow through a thickness of fabric containing one gram of material per unit area, and against the heat flow through the actual thickness of fabric.

Since porosity, which is the proportion of air volume in the fabric as compared to total volume of fabric, is one of the best ways in which fabrics made by different methods, weaving and knitting, can be compared, it seemed logical that it should give the best relationship. One of the conclusions arrived at through their own experiments[5] is that the distance at which a garment is worn from the body has more effect upon its value as an insulator than has the kind of material from which it is made, whether wet or dry, or whether the body is wet or dry. They also found that the relative permeability to moisture of clothing materials is of little importance in comparison with the effect due to the usual openings of the garments.

Rees[6] tried to simulate in his experiments actual conditions of wind and perspiration when he constructed his measuring apparatus. His conclusion for the effect of relative humidity on heat transmission is that while increasing the humidity increases the heat loss, the effect of such changes of humidity as are likely to be met with in service upon the thermal insulation of a fabric is small, provided there is no evaporation from the insulated body. On comparing different fabrics he found that the relationship between thickness and heat loss was in the shape of a hyperbola and decided that though thickness is not the only factor which determined the thermal insulation of a fabric, it certainly was one of the most important.

Baxter and Cassie[7] stressed the importance and the use of surface emissivity in determining heat insulating properties of clothing. Surface emissivities contain two heat transfer factors: that due to radiation, and that due to convection. Heat transfer by radiation will depend on the radiation properties of the fibers composing the fabric. Transfer by convection will depend on the roughness of the fabric surface.

Smooth-surfaced fabrics, with their relatively large surface emissivities will give good heat transfer from fabric and presumably from skin to fabrics; they will thus give clothing a large heat transfer even though the individual fabric may have the same thermal conductivity and thickness as a fabric with surface cover.

The surface emissivity of fabrics is important when the heat loss through single fabrics is considered; but its importance rapidly diminishes when only the outer surface of a number of layers of fabrics is considered.

THEORY

It is a known fact that fibers are better heat conductors than non-moving air. It follows that the more air within a fabric the better insulator the fabric will be. In a still air atmosphere the volume of air in a fabric can be con-

sidered as a more effective insulator than the fibers themselves. The percentage of air in a fabric is termed the porosity of the fabric.

Total porosity includes both entrapped and interspace porosity. In conditions of non-moving air a distinction between the two is not necessary. However, in conditions of moving air or wind, a distinction between entrapped and interspace porosity should definitely be made. Whereas entrapped air helps insulation when a fabric is exposed to air currents, interspace porosity reduces it considerably by allowing a free passage of air. The air permeability of a fabric then becomes, to some extent, a measure of interspace porosity.

From a knowledge of physics, we know that the resistance to heat transfer in a homogeneous medium is directly proportional to the thickness of a material. It is a logical assumption that the resistance to heat transfer of a fabric is a function of both porosity and thickness:

$$\frac{1}{H} = f(P \cdot t)$$

H = rate of heat transfer
P = porosity
t = thickness

The thicker of the two fabrics with the same porosity will be the better insulator; and for two fabrics with the same thickness, the fabric with the higher porosity will act as the better insulator. It also follows from the above considerations that as the porosity approaches a value of 100% (or 1.00), the fabric thickness has a maximum effect on insulation properties. In this case the insulation value of this fabric will be nearly the same as a layer of still air of the same thickness. As the porosity approaches zero, the effect of thickness will be negligible and the resistance to heat transfer will reside in the surface boundaries of the fabric.

The porosity of a fabric is dependent upon the apparent density of the fabric and the density of the fibers in the fabric:

$$P = \left(1 - \frac{d_a}{d_f}\right) 100 \quad \text{where} \quad d_a = \frac{1.33W}{t}$$

d_a = apparent density of fabric in g./cc.
t = thickness of fabric in mils
W = weight in oz./sq. yd.
d_f = density of fiber in g./cc.

The method for determining t, the fabric thickness, is very important and is discussed under the experimental procedure.

The validity of the previous assumptions can be established only by making a large number of measurements on different fabrics.

MATERIAL

Samples of fabrics for this work were selected for the purpose of the present study, i.e., the determination of the effect of physical characteristics of fabrics on their heat transmission property. Therefore, fabrics with physical characteristics as widely apart as possible were gathered. Although cotton and wool are the main fibers, rayon, nylon and orlon are included to determine if they have different thermal properties, or if they fall in line with either wool or cotton.

In the following table is a description of the samples. The symbols affixed to the fabrics will be used throughout this work when referring to them.

TABLE I

FABRIC SYMBOL	DESCRIPTION OF FABRICS	ENDS INCH	PICKS INCH
C_1	Grey, cotton voile, plain weave	64	75
C_2	White, cotton broadcloth, plain weave . .	91	88

TABLE I (*Continued*)

FABRIC SYMBOL	DESCRIPTION OF FABRICS	ENDS INCH	PICKS INCH
C_3	Fawn, cotton cellular shirting, plain weave using skip dent method	88	61
C_4	Grey, cotton drill, $\frac{2}{\quad 2}$ twill	125	60
C_5	Yellow, cotton open mesh, plain weave . .	25	24
C_6	Printed cotton flannel, plain weave, napped on one side	48	41
C_7	Green, cotton jean, $\frac{2}{\quad 1}$ twill . . .	64	42
C_8	Yellow, cotton flannel, plain weave, napped on both sides	45	44
C_9	Yellow, cotton corduroy, narrow wale . .	64	88
C_{10}	Red, cotton flannel, $\frac{2}{\quad 2}$ twill, napped on one side	62	48
C_{11}	Yellow, cotton corduroy, wide wale . .	59	107
C_{12}	Light blue, cotton quilt, small diamonds .	—	—
		WALES	COURSES
KC_1	Cotton, filling knitted webbing . . .	24	26
KC_2	Cotton interlock	38	32
KC_3	Cotton cellular webbing	18	28
KC_4	Cotton fancy webbing	22	35
KC_5	Cotton fancy webbing	26	28
KC_6	Cotton fine light webbing	30	44
		ENDS INCH	PICKS INCH
Wst_1	Green, worsted dress material, plain weave, clear finish	56	45
Wst_2	Cream, worsted material, $\frac{1 \quad 1 \quad 1}{\quad 3 \quad 2 \quad 1}$ twill, clear finish	54	50
Wst_3	Brown, worsted men's suiting, clear finish .	78	60
Wst_4	Blue grey, worsted ladies' suiting, clear finish	64	66
Wst_5	White, worsted ladies' suiting, $\frac{1}{\quad 2}$ twill, clear finish	43	55
Wl_1	Woolen ladies' coating, clear finish . . .	33	30
Wl_2	Woolen ladies' coating, short nap . . .	24	26
Wl_3	Shoddy blanket, napped and raised . . .	37	18
Wl_4	Double cloth men's overcoating, twill face and plaid back, napped and shorn . .	58	60
CWl_1	Reversible bathrobe, cotton warp, woolen filling, napped on both sides . . .	41	56
CWl_2	Same as CWl_1	49	62
CWl_3	Same as CWl_1	44	78
CWl_4	Same as CWl_1	43	52

Table I (Continued)

Fabric symbol	Description of fabrics	Ends inch	Picks inch
$CWst_1$	Cotton warp, worsted filling, shirting, plain weave, clear finish	61	60
CWR_1	Cotton warp, rayon and woolen filling, twill	31	26
WR_1	Shoddy wool quilt, rayon cover, large diamonds	—	—
R_1	Blue, filament rayon suiting, rep weave	70	42
R_2	Blue, filament rayon suiting	57	56
R_3	Green, spun rayon staple cloth, $\frac{2}{1}$ twill	102	58
R_4	Viscose rayon warp, acetate filling, lining material	—	—
N	Printed woven nylon material	107	111
KR	Warp knit tricot, viscose rayon	—	—
KN_1	Warp knit tricot, nylon	—	—
KN_2	Warp knit tricot, nylon	—	—
		Wales	Courses
KW_1	Brown knitted coating, woolen yarn, filling knit, fulled and napped	20	25
KW_2	Circular knit coating, worsted yarn, melton finish	—	—
KW_3	Circular knit coating, worsted yarn, light nap	—	—
KO	Warp knit orlon, tall pile on one side, used for ladies' coating	32	33

Table II

Densities of Fibers

Fiber	Density in g./cc.
Nylon	1.14
Orlon	1.17
Silk (degummed)	1.25
Dynel	1.31
Wool	1.32
Acetate Rayon	1.32
Dacron	1.38
Flax	1.50
Cotton	1.50
Viscose Rayon	1.52

APPARATUS

The apparatus used for this work was built at the Lowell Technological Institute[8]. It is of the hot flat plate type, and the principle is that of measuring the energy supplied to keep the plate at a constant temperature when subjected to a constant lower ambient temperature.

The apparatus consists of two parts: the cabinet with the refrigerating unit which encloses and creates the ambient atmosphere, and the hot plate with the electric automatic controls. Although the principle for heat measurement is not new (Rees[6], Cleveland[9] and other workers have used it), the apparatus is to be commended for the refinements in the automatic electric controls which make it possible to maintain conditions constant to within 0.5°C. in the cabinet and

in the plate, as well as measure accurately the amount of electrical energy supplied to the hot plate.

The hot plate unit is composed of a central copper plate heated by nichrome coils embedded in bakelite. A circular guard ring prevents any loss of heat from the sides of the copper plate and a lower guard ring prevents heat loss in a downward direction. The temperature of the central plate is automatically kept constant at a predetermined temperature higher than that of the cabinet. This is accomplished by a thermocouple electronic circuit controlling the current to the plate. Current to the hot central plate is provided by a battery to insure a constant voltage. The controls do not operate on an "on" and "off" manner, but on a "high" and "low." Should the temperature of the plate get below the specified temperature, a preset high current goes on; as soon as the balance is restored and the temperature of the plate tends to go higher than that setting, the low current goes on. In this manner the plate is constantly supplied with a minimum current to maintain the set temperature. The guard rings are maintained at the same temperature as the central plate thus avoiding a temperature gradient and eliminating heat losses from the sides and bottom. Each guard ring is regulated by a thermocouple circuit in such a manner that the slightest decrease in temperature below that of the central plate will allow current to go through the guard ring coils. As soon as equilibrium is restored the current goes off. This narrow control is made possible by the electronic circuit which includes a spotlight galvanometer, phototubes and relay switches.

The hot plate unit is enclosed in a cabinet 4′6″ x 2′11″ x 3′6″. The cabinet is of plywood construction on the outside and is lined with masonite board on the inside; granulated cork is between the masonite and plywood to improve heat insulation. A door, one foot square, with two layers of glass is provided for access into the cabinet. The door is kept closed while the experiment is on. The refrigerating unit is inside, whereas the motor, compressor and condenser are outside. The refrigerating unit is controlled by a thermostat set to prevent the temperature inside the cabinet from rising above 10°C. A 100-watt carbon-filament lamp placed at the bottom of the cabinet is connected to a thermoregulator. The lamp is switched on when the cabinet temperature reaches 9.5°C. and prevents further lowering. The lamp switches off at approximately 10°C. The temperature of the cabinet registered on a thermometer can be checked from the outside by means of a telescope.

It is possible to obtain a range of temperature gradients between the hot plate and the cabinet by means of a potentiometer. If the cabinet temperature is to be kept at 10°C. and a temperature gradient of 15°C. is desired, the hot plate will be provided with the current needed to maintain a temperature of 25°C. If the temperature difference desired is 25°C., the potentiometer control knob is moved to the 25°C. mark on the dial and the temperature of the plate is now brought up to 35°C. and maintained there.

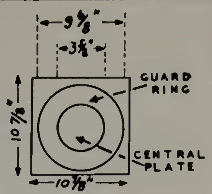
The current flow to the plate and the voltage are measured by an ammeter and voltmeter connected to the circuit. An electric clock is connected in such a manner as to start every time the "high" current goes on and to stop as soon as the "low" current goes on. The clock thus records the time during which the high current flows through the central plate circuit.

Two sketches of the apparatus are given in Figure 1 and Figure 2.

The fabric sample is placed horizontally on the central plate with no more pressure than its own weight.

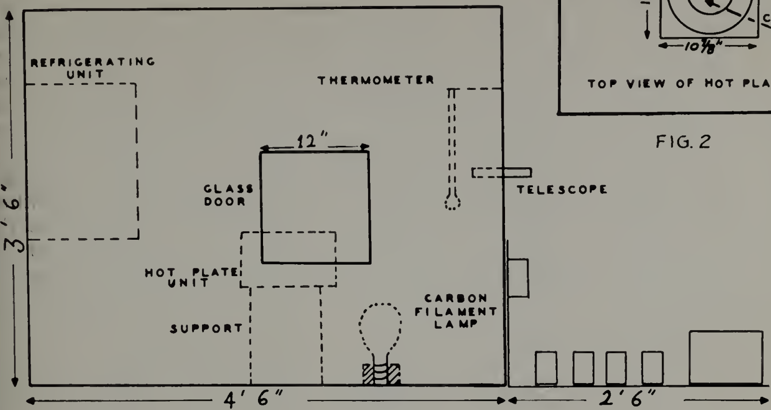
Each experiment lasts three or four hours and no supervision is necessary during the testing period.

An example of the procedure used is given in the following section.



TOP VIEW OF HOT PLATE UNIT

FIG. 2



FRONT VIEW OF CABINET (SCHEMATIC NOT TO SCALE) INSTRUMENT PANEL

FIG. 1

EXPERIMENTAL PROCEDURE

A. Measurement of Physical Characteristics

Construction, weight and permeability were measured according to ASTM standards; thickness, however, presented a special problem. Since it was somewhat expected that thickness would bear considerable influence in the conclusions derived from this work, it was essential to decide at what suitable pressure it should be measured. In order to find a correct relationship between thickness and heat transmission, it was obvious that the thickness measured should be that at which the fabric was to be tested. The ASTM standards specify a pressure foot of 0.375″ in diameter and a pressure of 3.4 lbs./sq. in. Although this pressure does not deform or compress clear finished fabrics unduly, it is completely unsuitable for pile or napped fabrics. An unreal thickness is measured by this method giving untrue density and porosity values. It was decided to use a lighter pressure with a larger presser foot. The compressometer developed by Scheiffer[10] was used with a presser foot one inch in diameter. A pressure of 0.364 lb./sq. in. was used at first. It was found that the thickness of the clear finished fabrics was not much different than when measured with the ASTM pressure, but those with surface cover, pile, or a nap were shown to be appreciably thicker. This pressure was still deemed unsatisfactory as it was observed that pile and nap were yet distorted by the presser foot. It was finally decided to read the thickness on the thickness dial as soon as the pressure dial registered a pressure above that of zero. An extension of 10/1000th of an inch of the spring in the compressometer was taken to be the desired pressure. This extension of the spring is equivalent to 0.085 lb./sq. in. with the one-inch presser foot. This pressure was the nearest to zero pressure that could safely be used on this instrument before introducing a change in thickness due to pressure. Five measurements were taken on each sample and averaged.

B. Conditions and Procedure of Heat Transmission Tests

The fabrics were conditioned and kept at standard atmosphere, 65% relative humidity and 70°F., at all times during the above physical measurements. Each

fabric was in turn taken from this atmosphere and placed on the hot central plate in the cabinet when ready for the test. In this manner each fabric was placed on the hot plate with its corresponding moisture regain at 65% relative humidity.

All tests were conducted at a temperature difference of 25°C. between the hot plate and the cabinet.

On starting the test the hot plate was allowed an hour to reach its temperature, i.e., 35°C., and to maintain it. The sample to be tested was placed on the hot plate with no more pressure than its own weight; particular care was taken to avoid any wrinkles. The sample was allowed 30 minutes to reach equilibrium with the hot plate on its lower surface and with the ambient temperature on its upper surface. It is obvious that during these 30 minutes, and later on during the test, the fabric will be continually losing the moisture which it contained when first placed on the plate. Also the rate of such loss will differ with the different fabrics, depending on their relative permeability to moisture. The moisture which has been driven from the fabric will go to increase the relative humidity of the cabinet, and thus slightly change the condition of the ambient atmosphere. Black and Matthew[11] and Rees[6] have shown, however, that neither of these changes in condition have any appreciable effect on the heat transmission.

The total heat lost through the fabric is given by the equation

$$\bar{C} = \frac{E_H I_H T_H + E_L I_L (t - T_H)}{4.19 A \theta t}$$

$\bar{C}$ = heat transmittance of fabric, calories/ (sec) (meter)^2 (°C.)
I_H = high current supplied to plate
I_L = low current supplied to plate
E_H = voltage for I_H
E_L = voltage for I_L
T_H = time in seconds of high current flow
t = total duration of test in seconds
A = area of central hot plate in square meters
θ = temperature difference between hot plate and ambient atmosphere

The values of $\bar{C}$ for all the fabrics tested are given in Table III.

TABLE III

Fabric symbol	Weight W, oz./sq. yd.	Thickness t in mils at 0.085 lb./sq. in.	Apparent density d_a, g./cc.	Porosity P in %	$\frac{P}{100} \times t$	Heat transmittance $\bar{C}$
C_1	1.80	7.2	0.333	77.8	5.6	2.46
C_2	3.84	10.7	0.478	69.6	7.4	2.46
C_3	3.14	11.0	0.380	74.6	8.2	2.29
C_4	5.64	14.6	0.510	66.0	9.6	2.35
C_5	3.43	19.0	0.240	84.0	16.0	2.23
C_6	4.85	22.5	0.286	80.9	18.2	1.94
C_7	6.07	21.6	0.374	75.0	16.2	2.27
C_8	3.58	36.8	0.129	91.4	33.6	1.72
C_9	6.08	33.8	0.240	84.0	28.4	2.20
C_{10}	8.08	51.6	0.209	86.1	44.5	1.87
C_{11}	7.45	52.1	0.190	87.3	45.4	1.91
C_{12}	5.86	49.7	0.157	89.5	44.0	1.52
KC_1	5.75	41.2	0.186	87.6	36.1	2.05
KC_2	5.62	40.0	0.187	87.5	35.0	2.10
KC_3	5.70	32.8	0.232	84.5	27.7	2.21
KC_4	5.40	30.8	0.234	84.4	26.0	2.15
KC_5	7.20	48.0	0.200	86.7	41.6	1.72
KC_6	2.96	17.6	0.224	85.1	15.2	2.24
Wst_1	4.85	19.9	0.324	75.4	15.0	2.40
Wst_2	7.30	24.1	0.404	69.4	16.7	2.49
Wst_3	9.57	25.7	0.495	62.5	16.1	2.59
Wst_4	9.27	29.0	0.425	67.8	19.6	2.34
Wst_5	8.85	33.0	0.357	73.0	24.1	2.24
Wl_1	13.40	75.8	0.236	82.2	62.3	1.79
Wl_2	12.50	68.2	0.244	81.5	55.7	1.95
Wl_3	14.30	128.8	0.148	88.8	114.0	1.46
Wl_4	25.00	126.0	0.264	80.0	100.7	1.68
CWl_1	12.20	127.6	0.128	91.0	116.0	1.36
CWl_2	13.70	126.8	0.144	89.8	114.0	1.51
CWl_3	11.40	153.6	0.099	93.0	143.0	1.34
CWl_4	14.10	158.2	0.119	91.5	146.0	1.25
$CWst_1$	3.45	12.4	0.370	73.7	9.1	2.45
CWR_1	10.00	76.8	0.174	88.0	67.5	1.70
WR_1	8.60	101.8	0.113	92.0	93.6	1.34
KWl_1	12.25	94.0	0.173	86.9	81.6	1.64
$KWst_1$	12.45	74.4	0.223	83.1	61.8	1.76
$KWst_2$	16.10	113.8	0.189	85.7	97.5	1.50
R_1	6.00	13.9	0.575	62.2	8.6	2.60
R_2	7.00	18.7	0.499	67.2	12.5	2.53
R_3	6.70	18.9	0.472	68.9	13.0	2.58
R_4	1.43	6.0	0.318	77.6	4.7	2.48
N	1.17	2.5	0.625	45.3	1.1	2.60
KR	3.32	13.0	0.340	77.6	10.1	2.60
KN_1	1.89	7.7	0.328	71.2	5.5	2.73
KN_2	3.82	10.6	0.480	57.9	6.1	2.70
KO	8.20	127.0	0.086	92.6	117.4	1.52

DISCUSSION OF RESULTS

Separate plots were made of heat transmittance $\bar{C}$ of all the fabrics tested and each of the following quantities: air permeability, weight per unit area, fabric thickness, porosity, and porosity multiplied by thickness.

No correlation was found in the plots involving air permeability or weight per unit area. There was good correlation between heat transmittance and thickness of all fabrics tested. When separate plots were made for the cotton and for the wool groups, it was evident that the fiber content had very little effect upon the results. These conclusions agree with the work of previous investigators who have found that the relationship between heat loss and thickness can be expressed by a hyperbolic-shaped curve which approaches both axes in the plotting area.

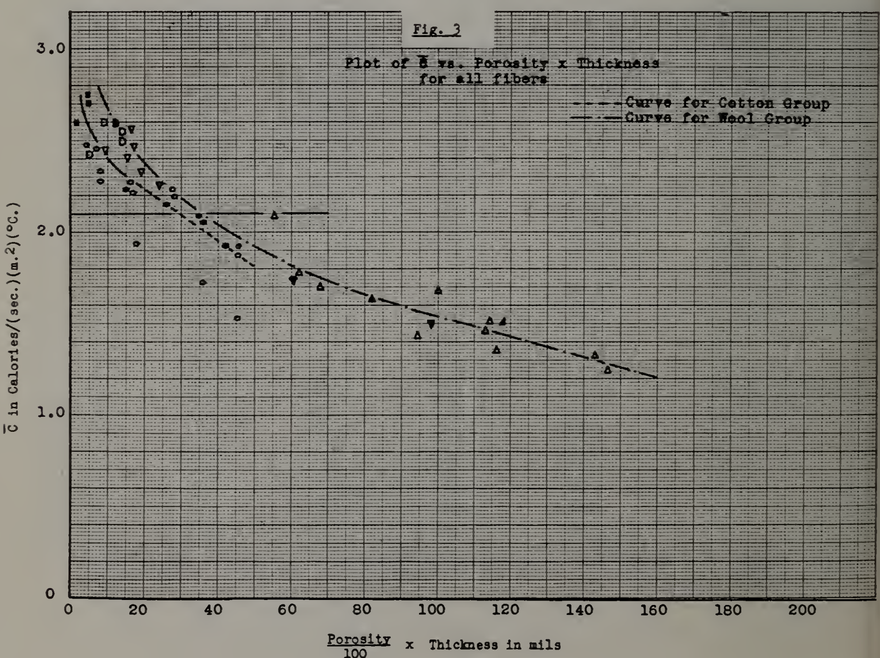
The plot of heat transmittance and porosity indicated a small degree of correlation between these quantities. As the porosity increased, the heat transmittance tended to decrease linearly, but the plotted prints were widely scattered around any straight line which could be drawn to illustrate the relationship.

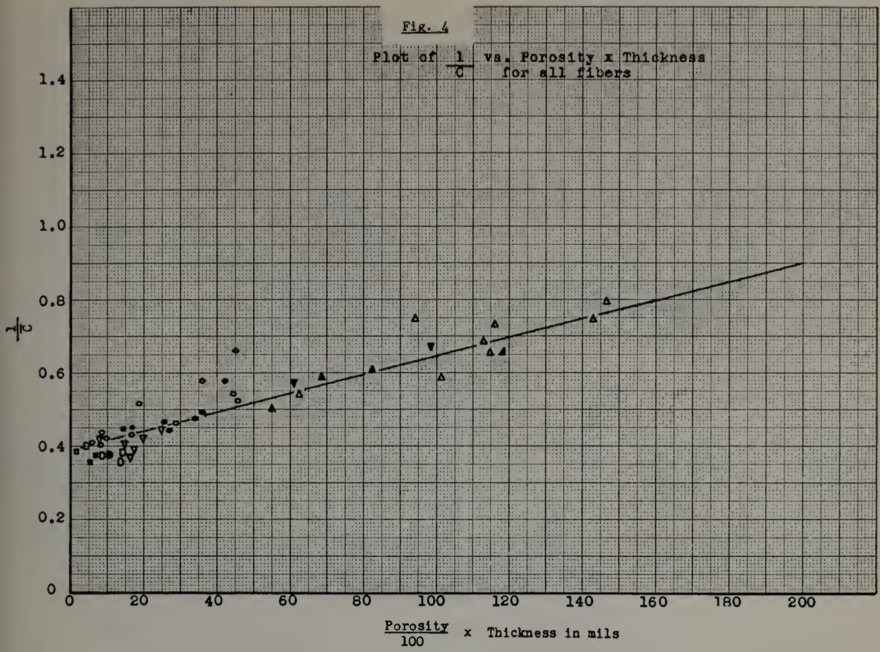
The best correlation was found in the plot of heat transmittance and porosity times thickness. Figure 3, below, shows that 42 of the 46 fabrics tested are grouped very closely about the two curves which are drawn. One curve could be drawn for all the points showing the effect of porosity and thickness since the nature of the fiber does not seem to play an important part.

The plot of $\frac{1}{\bar{C}}$ and porosity times thickness is shown in Figure 4. $\frac{1}{\bar{C}}$ is approximately a linear function of P · t, and the equation found by the method of least squares is

$$\frac{1}{\bar{C}} = 0.385 + 0.0000257\,(P \cdot t)$$

where $\bar{C}$ is expressed in calories/ (sec) (meter)^2 (°C.), P is porosity in per cent, and t is thickness in mils.





In Figure 3, a straight line was drawn through the point corresponding to $\bar{C} = 2.10$. All the fabrics having heat transmittances above this value had no insulating properties when placed over a heated metal plate. The fabric covered plate transmitted more heat to the surrounding atmosphere than the bare plate. The phenomenon that some fabrics can actually increase the heat loss of a body when covering it, instead of reducing it, has been reported by Marsh[2]. A partial explanation of this phenomenon can be found in a paper by Baxter and Cassie[7] on the importance of surface emissivity in fabrics.

Probably all fabrics have a higher surface emissivity than a smooth metal plate, and when a thin fabric is placed over the metal plate, heat loss is increased. Another explanation can be found by re-examining the plots for thickness, porosity and $P \cdot t$. Those fabrics above $\bar{C} = 2.1$ show a low porosity, a low thickness, and a low value of $P \cdot t$. We acknowledge the fact that fibers are better heat conductors than air, therefore it may be that those fabrics with low porosity and thickness just did not have enough porosity and thickness to counteract the high conductivity of their fibrous material. It is only when porosity and thickness attain a sufficiently high value that effective insulation can begin to take place. This combination of porosity and thickness can be attained by the construction of the fabric and its finish. Apart from reducing emissivity, a raised, napped or pile fabric will create the necessary porosity and thickness to offer effective insulation.

Not only are the percentage of porosity and the thickness important for effective insulation, but the manner in which the air is contained in the fabric also will determine how effectively it will act as an insulator. Figure 3 and Table I will help illustrate and explain this point.

It will be noticed in Figure 3 that for any value, or small range of values, of $P \cdot t$ there are different values of $\bar{C}$, especially at the lower values of thickness. Within the range of 15 to 20 for $P \cdot t$ values of $\bar{C}$ are from 1.9 to 2.6. Also, contrary to common belief and expectation, cotton fabrics show a lower transmission of heat than wool fabrics at those values. The fabrics included in the range mentioned are, from lower values of $\bar{C}$ to higher values: C_6, C_5, KC_6, C_7,

Wst_4, Wst_1, Wst_2, and Wst_3. From the description in Table I it is evident that the fabrics showing lower heat transmission have a surface cover such as a nap or pile which may reduce the emissivity. Also the particular construction of these fabrics provides smaller air spaces and pockets, thus increasing the insulating value of the air contained. The knitted cotton fabric is a good illustration.

CONCLUSIONS

Measurements made on 46 fabrics of different fiber content and of different physical characteristics indicate that fabric thickness modified by a porosity coefficient has the greatest effect upon heat transmittance.

The reciprocal of heat transmittance, or insulating value, of 41 of the fabrics can be well expressed by the equation

$$\frac{1}{\bar{C}} = 0.385 + 0.0000257\,(P \cdot t)$$

when $\bar{C}$, P, and t are expressed in proper units. The equation applies only for conditions similar to those described in the experimental procedure where one side of the fabric was in contact with a hot metal surface and the other side was exposed to still air.

Other factors which influence heat transmittance, such as surface emissivity, will have to be evaluated before a complete equation can be written.

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BULLETIN OF THE

LOWELL TECHNOLOGICAL INSTITUTE

Lowell, Mass.

L T I

Catalogue Issue

1956-1957

Aerial View of Campus

Air Force ROTC Color Guard

SERIES 59, NO. 4 *May, 1956*

BULLETIN

of the

Lowell Technological Institute

LOWELL, MASS.

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1956

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Textile Avenue and Colonial Avenue

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The Institute reserves the right to make changes in the regulations, courses, and charges announced in this Bulletin.

INSTITUTE CALENDAR
FOR
ACADEMIC YEAR 1956-1957

1956

September 10, Monday, 9 A.M.	Freshman Orientation Week begins. Registration of Graduate Students begins.
September 13, Thursday, 9 A.M.	Registration of Upperclassmen begins.
September 14, Friday, 4 P.M.	Registration of all classes ends.
September 17, Monday, 8 A.M.	Undergraduate classes begin.
September 18, Tuesday, 8 A.M.	Graduate classes begin.
September 28, Friday	Last day to register for new classes.
October 11, Thursday	Last day to drop classes without penalty.
October 12, Friday	Columbus Day. Institute closed.
November 12, Monday	Veterans' Day observance. Institute closed.
November 28, Wednesday, 12 Noon	Thanksgiving recess begins.
December 3, Monday, 8 A.M.	Classes resume.
December 21, Friday, 12 Noon	Christmas recess begins.

1957

January 7, Monday, 8 A.M.	Classes resume.
January 14, Monday	Registration for second semester begins. Classes continue.
January 21, Monday, 8 A.M.	First semester examinations begin.
January 30, Wednesday, 5 P.M.	First semester examinations end.
February 1, Friday	Registration for second semester ends.
February 4, Monday, 8 A.M.	All classes begin.
February 15, Friday	Last day to register for new classes.
February 22, Friday	Washington's Birthday. Institute closed.
March 1, Friday	Last day to drop classes without penalty.
April 12, Friday, 5 P.M.	Easter recess begins.
April 22, Monday, 8 A.M.	Classes resume.
May 27, Monday, 8 A.M.	Second semester examinations begin.
May 30, Thursday	Memorial Day. Institute closed.
June 7, Friday, 5 P.M.	Second semester examinations end.
June 16, Sunday	Baccalaureate and Commencement.

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ALUMNI ASSOCIATION

Objects of the Alumni Association are to advance the interests of Lowell Technological Institute, to secure systematic and unlimited gifts thereto and to receive and hold money and property, both real and personal, and to manage, use, and dispose of the same as appears to be in the best interests of the Institute.

All students of the Institute who have completed satisfactorily at least one year of the day curriculum are eligible for active membership. Only the active members have the right to vote and hold office in the Association.

The by-laws of the Association also provide for Honorary and Associate memberships. The Honorary Membership Scroll and Citation may be awarded by the Board of Directors to any person who has made outstanding contribution to the arts or sciences. Any person not otherwise eligible for membership who has made significant contribution to the welfare of the Institute may be elected to Associate membership by the Board of Directors. The Honorary Award Scroll and Citation may be awarded by the Board of Directors to any active member of the Alumni Association who has made outstanding contribution to the arts or sciences.

The Association administers numerous scholarships and fellowships; publishes the magazine, "The L.T.I. Alumni Bulletin," three times annually; publishes an Alumni Directory; aids student organizations; and performs the functions usually associated with alumni organizations. Membership is held in the American Alumni Council.

The Association holds its annual business meeting and banquet in the spring of each year.

Communications should be addressed to Professor A. Edwin Wells, Executive Secretary, Alumni Office, Lowell Technological Institute.

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RESEARCH FOUNDATION

In recognition of the unique research opportunities afforded to industry by virtue of the equipment and staff available at Lowell Technological Institute, the Massachusetts State Legislature, in November 1950, authorized the establishment of the Lowell Technological Institute Research Foundation. Its purpose is to conduct research, development, and consulting programs under contract with responsible agencies and industrial organizations. This activity has the effect of permitting staff members access to new and significant developments in the textile and other industries and materially assists in keeping the teaching programs current and dynamic.

The Research Foundation provides the necessary mechanism whereby all of the research work of the Institute is brought under one coordinating office headed by the Executive Director. As in the past, however, the faculty of the Institute does the greater part of the research work. This plan has been proved through years of experience to be highly beneficial to both the Institute and industry.

The Foundation has the use of the Institute's laboratory and research facilities in chemistry, physics, engineering, textiles, electronics, paper, leather and plastics. The Institute has many unusual research facilities. These include a completely equipped laboratory for work with radio-active materials, an Instron tester, x-ray diffraction equipment, a large spectrograph, recording spectrophotometers, a pulse-propagation meter, and a completely equipped laboratory for microscopic work including phase microscopy and electron microscopy.

It is probably the only research organization in the world having at its disposal fully equipped laboratories to manufacture and finish nearly all types of fibers by all the common manufacturing systems as well as similar equipment for paper, leather and plastics processing. These splendidly equipped laboratories serve as pilot plants for the evaluation of industrial and manufacturing problems submitted to the Foundation.

The Foundation organization is built around the three basic divisions of Research, Development, and Testing, and is currently active in all three fields for both governmental agencies and industrial organizations.

For further information and descriptive literature about the Research Foundation, write to Mr. Dorrance H. Goodwin, Director of Research Services, Lowell Technological Institute Research Foundation, 1 Textile Avenue, Lowell, Mass.

Lowell Technological Institute

GENERAL INFORMATION

History

Lowell Technological Institute was incorporated in 1895 and formally opened for the teaching of textile manufacturing subjects on January 30, 1897. It was then known as the Lowell Textile School and awarded only certificates and diplomas. Growth of the school in size, prestige, and scope of curricula was rapid, and in 1913 it was granted the right to give regular four-year degrees in textile engineering and textile chemistry.

In 1928 the name was changed to the Lowell Textile Institute to indicate more fully its collegiate status. Its continued growth resulted in further diversification of its areas of specialization and in 1950 it entered the fields of paper engineering and leather engineering. Electronic engineering was added in 1953 and plastics engineering in 1954. A course in general engineering will be introduced in September of 1956.

In view of the present greatly expanded scope of its engineering program, its name was once more changed in 1953 to the Lowell Technological Institute. The Institute grants Bachelor of Science and Master of Science degrees and is authorized to set up a program leading to the doctorate.

Since 1918, when the property of the school was transferred to the Commonwealth of Massachusetts, it has been under the control and management of a Board of Trustees appointed by the Governor.

Accreditation

The Institute is a full member in the Senior College Division of the New England Association of Colleges and Secondary Schools. The United States Department of Education and the Armed Forces consider such membership equivalent to regional accreditation. The Engineers' Council for Professional Development extends full accreditation to the curricula in textile engineering.

Graduates of this Institute have been accepted for graduate study at nearly all leading universities. The Institute's prestige in its early field of specialization, textiles, has attracted students annually to L.T.I. from approximately 35 other countries.

Coeducation

The Institute accepts both men and women for entrance provided they are properly qualified graduates of an accredited

secondary school. While the great majority of its students are men, the Institute has attracted for some years a small but significant group of young women who recognize the increasing opportunities open to technically trained women in industry.

Location

Lowell Technological Institute is located in Lowell, Mass., a city of 100,000, long famous as a textile center and more recently as a city of increasingly diversified industries. The campus is composed of ten main buildings located on a 15-acre site along the west bank of the Merrimack River and overlooking the rapids of Pawtucket Falls. The campus site was donated by Frederick Fanning Ayer, Esquire, and the Proprietors of the Locks and Canals on the Merrimack River.

Buildings

Southwick Hall. This was the first building erected on the present campus and was dedicated in 1903 as the gift of the Commonwealth of Massachusetts and Mr. Frederick Fanning Ayer. It is a memorial to Royal Southwick, an ancestor of Mr. Ayer and a leading textile manufacturer and public figure of his day. It contains the gymnasium, student mail room, administrative offices of the four faculty divisions and the AFROTC detachment, and the national headquarters of the American Association of Textile Chemists and Colorists.

Kitson Hall. Completed in 1903, Kitson Hall was erected by Charlotte P. Kitson and Emma K. Stott as a memorial to their father, Richard Kitson, founder of the Kitson Machine Company of Lowell. It contains classrooms and laboratories.

Falmouth Street Building. Erected in 1903 as a one-story building, it was enlarged to its present capacity for classroom and laboratory facilities in 1907 by the Commonwealth of Massachusetts.

Louis Pasteur Hall. Originally constructed as a one-story building, it was enlarged to four stories in 1937 by the Commonwealth of Massachusetts and houses laboratories and classrooms as well as the national research laboratories of the American Association of Textile Chemists and Colorists.

Paper and Leather Building. Completed in 1952 by the Commonwealth of Massachusetts, this modern building houses complete leather and paper manufacturing facilities, advanced textile testing and electronic laboratories, as well as many modern lecture rooms.

Alumni Memorial Library. Erected in 1951 by the Alumni Association through contributions from alumni and friends of the

Institute, this modern library is dedicated to the men and women of the Institute who served this nation in World Wars I and II and the Korean conflict.

Besides a book stack capacity of 80,000 volumes, it contains student activity offices, alumni offices, reading rooms, typing facilities, micro-film room and faculty studies. It houses one of the most complete collections of textile books in the world and numerous special collections in the fields of paper, leather, chemistry, electronics, and plastics. It also serves as a depository for U. S. Government publications and is available to industrial concerns through its Industrial Corporate Membership program.

Cumnock Hall. Completed in 1954, this auditorium-administration building provides a 1200-seat auditorium for academic convocations and social activities. It also contains the offices of the President and Assistant to the President, the Dean of Faculty and the Dean of Students, Graduate School, Admissions, Special Services, Placement, the Bursar, the Registrar, and the L.T.I. Research Foundation.

Smith Hall. Erected in 1948 by the Lowell Textile Institute Building Association, Smith Hall has living accommodations for 112 students. The basement contains the college cafeteria and a medical dispensary. It is dedicated in honor of James T. Smith, pioneer educator in the textile field and the individual primarily responsible for the organization of the Lowell Textile School in 1895.

Eames Hall. The second men's residence hall was completed in 1949 by the Lowell Textile Institute Building Association and contains living quarters for 112 students, a student lounge and recreation center, and a snack bar. It is dedicated in honor of Charles H. Eames, President of the Institute from 1905 to 1945.

Equipment

The total value of the scientific and industrial equipment used in the instructional and research program of the Institute is approximately five million dollars. This equipment ranges from the most delicate scientific instruments, such as the electron microscope, to full-sized industrial machines.

The textile manufacturing equipment includes a full line of machines for processing any fiber, whether natural or man-made, on the cotton, woolen, French worsted, English worsted or American worsted systems. It also includes a modern throwing plant for filament yarns and a garnetting unit to reclaim used fibers.

All types of modern looms and knitting machines together with a full line of wet and dry finishing equipment enable the In-

stitute to manufacture, under almost all industrial conditions, any type of fabric and finish desired.

The textile testing laboratories are among the most completely equipped in the world and have the use of the extensive optical and electronics facilities used in advanced research work.

In the completed equipped paper and leather laboratories both leather and paper of nearly all grades and types can be fully processed from raw materials, finished, and tested by the most modern methods, and an ambitious program of replacement of machinery is under way which will make the Institute eventually the finest equipped and most completely modernized of any in the country.

The wide variety of electronic and plastics equipment already available is in the process of being greatly augmented and consolidated in the new expanded electronics and plastics laboratories.

Complete mechanical, electrical and chemical laboratories of the usual types round out the unusual variety of equipment available for instruction and research.

ADMISSION OF UNDERGRADUATES

New students at the Lowell Technological Institute are selected from those applicants who, during their preparatory education, have shown promise in scholastic ability and strength of character. In addition to scholastic rating and test results, a high value is placed on evidence of leadership and contributions to school and community life.

Application Procedure

Formal application for admission should be made as early as possible after the first marking period in the candidate's senior year of secondary school. Students from other countries are strongly advised to begin admission procedures not less than twelve months in advance of the expected date of enrollment.

Preliminary correspondence before the senior year is welcome and frequently helpful to the student in planning his secondary-school program to fit the needs of his freshman year at the Institute.

Requests for application blanks and all correspondence relating to matriculation at the Institute should be addressed to the Director of Admissions.

Steps to be taken for admission follow:

1. Pages one and two of the admission application form should be completed by the candidate.

2. Attach a certified check or money order in payment of the application fee of $10. (See "Student Expenses" for explanation.)

3. The whole application form should then be submitted to the office of the candidate's secondary-school principal, with the request that his office fill out pages three and four and mail the completed application directly to the Director of Admissions.

It is recommended that this procedure be accomplished as soon as possible in the candidate's senior year in secondary school so that he may be considered for admission to classes beginning the next September.

4. All candidates for scholarships should make direct application to the College Entrance Examination Board, P. O. Box 592, Princeton, New Jersey, with a request to take the Scholastic Aptitude Test, described later in this section.

5. Each applicant must submit to a complete health examination by his family physician. A certificate of good health, indicating the date of this examination, must then be sent by the physician to the Director of Admissions. The Institute has prepared a spe-

cial form for the convenience of the physician; a copy of this certificate of health will be supplied.

6. A personal interview with the Director of Admissions is strongly recommended. The Office of Admissions at the Institute is open for this purpose Monday through Friday, from 8:30 A.M. to 4:00 P.M. during the school year. *It is urged that appointments for interviews be made in advance.*

Requirements for Admission

The Director of Admissions, in conjunction with the Committee on Admissions, reviews all applications to determine the eligibility of each candidate for matriculation. The final decision as to the eligibility of an applicant shall be left to the discretion of the Institute.

The conditions under which an applicant may be accepted are as follows:

1. A candidate for admission must be a graduate of a secondary school approved by the New England Entrance Certificate Board, the Regents of the State of New York, or a Board of equal standing.

2. (a) Because of the specialized nature of the various curricula at Lowell Technological Institute, it has been deemed advisable that all entering students shall have completed the following units of secondary-school study:

Algebra (quadratics and beyond)	2 units
Plane Geometry	1 unit
English	4 units
American History	1 unit
Chemistry (including laboratory)	1 unit
or	
Physics (including laboratory)	1 unit

Preference will be given to applicants offering both chemistry and physics. In addition to the above-listed prerequisites, each applicant must offer credit in elective subjects, such as languages, other than English; history, other than American; mechanical drawing; solid geometry; advanced algebra; scientific subjects; social studies, and others. Trigonometry is recommended but not required.

(b) The combined prerequisites and electives should total at least 15½ Carnegie units. Each such unit of preparatory credit is the equivalent of one secondary-school subject satisfactorily pursued during one academic

year of at least thirty-six weeks of four forty-minute meetings each week, or the equivalent.

(c) In evaluating the credits offered by an applicant for admission, the Institute will be guided primarily by the quality of his scholastic record and by his apparent promise on grounds of intellect and character. Therefore, an applicant whose preparation has not followed the normal pattern with respect to the accumulation of unit credits should not hesitate to apply for entrance, provided that the quality of his scholarship gives evidence of ability to do college work and provided that he is recommended by his school. (For additional information, see paragraph "Exceptions to Admission Rules" below.)

3. All candidates for admission who are also applying for a scholarship must complete the Scholastic Aptitude Test which is prepared, administered, and graded independently of Lowell Technological Institute. Application to take the test must be made directly to the College Entrance Examination Board, P. O. Box 592, Princeton, New Jersey. Arrangements to take the test, no later than May, should be completed as early as possible in the candidate's senior year in secondary school.

Exceptions to Admission Rules—In special cases, at the discretion of the Committee on Admissions, applications may be accepted from candidates in the following categories:

1. Applicants who lack credit in specified required subjects because they are not offered in the course of study at their secondary school. Such applications will be considered only when the quality of work done in other departments is exceptionally high.

2. Applicants who offer credit in all the required subjects, but whose accumulation of unit credits does not total 15½. Very few students will find themselves in this category, because most secondary schools require at least 15½ units for graduation. However, the Institute is willing to recognize the possibility that a student, well-qualified in all other respects, should not be denied the opportunity to submit his application because of purely quantitative considerations.

Admission With Advanced Standing

Transfer students must submit transcripts of their college record, a copy of their college catalogue and letters of honorable dismissal well in advance of their planned transfer date. The

Director of Admissions and appropriate Department Heads will gladly advise prospective applicants concerning their plan of study.

Transfer credit will be given for courses satisfactorily completed that are the equivalent in quality and scope of those given at the Institute. Final decision on transfer credit rests with the Divisional Chairman in charge of the subject for which transfer credit is desired.

Special Students

Qualified applicants may be accepted for specialized work not leading to a degree. The plan of study should have a clearly defined objective and should not deviate markedly from the regularly formulated subject matter and laboratory courses at the Institute. Admission as a special student is contingent upon approval by the Director of Admissions and the Divisional Chairmen concerned in the proposed program.

Students from Other Countries

Each year Lowell Technological Institute accepts for admission foreign applicants up to 5% of the total number of students in any given class (freshman, sophomore, etc.). There are no special procedures to be observed by foreign candidates, although it is urged that they endeavor to have the transcript of their secondary-school and/or college records, as well as all other admission materials, submitted, in English, *not less than twelve months in advance of the expected date of enrollment.* All applicants should have a considerable facility in speaking and writing English, and have financial resources sufficient at least for their first year of study. Foreign students will be expected to complete the same schedule of courses as is assigned to all other students.

In all respects, the admission procedures for foreign students are identical with those required of U. S. citizens.

To facilitate their adjustment to the life of the campus, all male students from other countries are required to live in the residence halls of the Institute and are assigned room space, shared jointly with American students. Students attending for the first time should note that towels, sheets, pillowcases, and blankets must be supplied by occupants of rooms. Students are therefore reminded that bedding, as well as clothing, should be suitable for a climate in which temperatures normally fall well below the freezing point during the winter months.

STUDENT HOUSING AND SERVICES

Residence Halls

All male students are required to live in the residence halls unless excused in writing by the Dean of Students. These excuses are subject to review at the beginning of each semester and may be cancelled should conditions warrant.

Application for permission to occupy other living quarters will be made on special blanks available at the Dean of Students' Office. An application must be filed annually by each student. Deadlines for filing applications are: (a) for all new students (incoming freshmen, transfer students, special students, or graduate students)—on or before September 1 of each year; (b) for all regularly enrolled students—on or before June 1 of each year.

In granting special permission to live outside the residence halls, the Dean of Students will give full consideration to the following:

a. Distance from Institute to place of legal residence.
b. Financial hardships involved in living in residence hall.
c. Year of the student, (freshman, sophomore, junior, senior, graduate).
d. Membership in fraternities that maintain a fraternity house.

Rooms are furnished by the Institute but are cared for by the students occupying them. Sheets, pillowcases, blankets, towels, and other personal linens must be supplied by each student. Each occupant is held responsible for any damage done to furniture and equipment.

Assignments of rooms in the residence halls are made through the Office of the Dean of Students. All assignments are for the full academic year. Change of room is not permitted except under unusual circumstances, and may be accomplished only after a formal application has been approved by the Dean of Students.

All rentals are uniform, the annual charge being $275 per academic year for each student. While this charge covers occupancy during periods that the Institute is regularly in session, it may, at the option of the Institute, be extended to vacation periods.

Assignments of rooms are made as equitably as possible and in the order that applications are received. For those students who are unable to be placed in residence halls, the Dean's Office supplies a list of approved rooming houses where students may reside.

Dining Hall

Dining facilities are provided on the campus in a cafeteria located on the ground floor of Smith Hall and in a snack bar located in the Students' Lounge in Eames Hall. These facilities provide additional opportunities for the students to become better acquainted as well as assuring wholesome food and a balanced diet.

Guidance

The guidance program begins with the admission procedures, continues throughout the undergraduate years, and culminates in the work of the Placement Office.

Guidance in the freshman year stems mainly from the results of the diagnostic testing program, Freshman Week activities, the Effective Study Course and the work of the Faculty advisers. These advisers function throughout the freshman year. During the sophomore, junior and senior years the heads of departments and the Dean of Students take over the primary responsibility for the students' personal and scholastic guidance.

The Office of the Dean of Students is open to all undergraduates from 9 a.m. to 5 p.m. daily to assist the student in attaining his academic objective, and to assure his active, enjoyable participation in the work and affairs of the Institute.

The Placement Office functions as a natural outgrowth of the undergraduate guidance program. This office endeavors to keep Institute undergraduates and graduates in constant contact with the latest developments in industry to insure placement in positions best suited to their talents and abilities.

Health Service

The dispensary, in Smith Hall, is in charge of a registered nurse eight hours each school day. She is on call 24 hours daily, including week ends. Students receive first-aid treatment at the dispensary, and are advised as to the best procedure in case of illness.

Medical services are available to the Institute 24 hours daily. If any student requires hospitalization, the college physician will arrange for admission to one of the three excellent, modern hospitals located in the immediate vicinity of the Institute. Medical fees and hospital charges are at the expense of the student.

Accident insurance during the academic year is compulsory and is included in the Activity and Insurance Fee. Sickness insurance is also available on a voluntary basis through the Office of the Dean of Students.

STUDENT REGULATIONS

Conduct

Students admitted to Lowell Technological Institute are assumed to be ladies and gentlemen, and of sufficient maturity and poise to enable them to live in an adult environment. Such living involves full respect for the rights of others, a regard for self-discipline and good order, and a high standard of honesty and of moral conduct.

In consequence of these assumptions, the regulations are framed not to restrict the conduct of individuals or groups of students, but, rather, to set forth the basic policies of the Faculty established in order that a large student body may live and work harmoniously together with a minimum of friction and misunderstanding. By the same token, even though the rules are neither detailed nor comprehensive, a student may be dropped from the rolls, or subjected to other disciplinary action, for conduct which is illegal, immoral, or inimical to the best interests of the Institute, regardless of whether or not the particular offense is listed in these rules and regulations.

Attendance

Attendance is expected of all students at all classes. The supervision of student attendance is lodged in the Office of the Dean of Students, both as to the announcement of detailed instructions and as to the enforcement of the rules established by the Faculty. Students charged with unexcused absences, particularly absences immediately before and after holiday and vacation periods, are subject to disciplinary action.

Disciplinary Action

Disciplinary action originates in the Office of the Dean of Students. Such action may be in the form of any of the following degrees of severity: Censure, Restriction, Suspension, or Dismissal. Whenever disciplinary action is taken, a notation of such action becomes a part of the permanent record of the student.

Academic Grades

The students' grades are reported by letter as follows:

A	90-100	F	Below 60, Failure
B	80-89	I	Incomplete
C	70-79	W	Withdrawn
D	60-69	X	Dropped

The student's semester rating is a weighted value used to denote his relative standing. The point values assigned are A = 4 points, B = 3 points, C = 2 points, D = 1 point and F = 0 points. These point values, when multiplied by the credit hours assigned to the subject and added together, are divided by the sum of the credit hours, to give the student's semester rating. The cumulative rating for more than one semester will be obtained in the same manner as the computation for the rating of a single semester.

Scholastic Reports

Reports of scholastic standing are compiled regularly at the end of each semester and formal notification of each student's status is made at that time.

Dean's List

The Dean's List is composed of those students who have a semester rating of 3.00 or higher, with no current failures.

Probation

A student is placed on probation when his semester rating is below 1.25. The probationary period covers the entire semester following the issuance of the semester rating which placed the student on probation.

A student with a rating of less than 1.25 for two consecutive semesters may be dropped from the Institute for at least one semester.

A student on probation may not represent the Institute in any public function and may not hold class or other offices during his term of probation.

If a student receives a semester rating below 0.50, he may be automatically dropped from the Institute without benefit of a probationary period.

REQUIREMENTS FOR GRADUATION

Only those students who have satisfied the following minimum requirements will be recommended for the baccalaureate:

(1) Complete successfully one of the prescribed curricula with no substitutions for major subjects therein and no unremoved failures in a major subject.

(2) Earn a cumulative rating of 1.5 or better for the entire period at the Institute.

(3) Pass 80% of the credit hours offered towards the degree with grades higher than D.

Graduation Honors

Academic honors are awarded at the annual Commencement Exercises by appropriate notation on the diplomas for the baccalaureate degree, and by printing in the commencement program the names of students who have earned such recognition. Honors are awarded according to the following standards of achievement:

a. Any student who graduates with a rating of 3.00–3.49 for the entire period of study at the Institute shall be awarded the baccalaureate degree *"With Honors"*.

b. Any student who graduates with a rating of 3.5 or better for the entire period of study at the Institute shall be awarded the baccalaureate degree *"With High Honors"*.

c. The highest ranking student in each graduating class who graduates with a rating of 3.8 or better, and who has completed at least six semesters of work at the Institute, shall be awarded the baccalaureate degree *"With Highest Honors"*.

STUDENT AWARDS

The following awards are made annually:

(1) *American Association of Textile Chemists and Colorists Book Prize*

Awarded to the outstanding graduating senior in the course of Textile Chemistry. The recipient is selected by the Chemistry Division and the academic standing of the candidate is an important factor. The award includes a junior membership for one year in the A.A.T.C.C.

(2) *American Association for Textile Technology Award*

Given annually to the member of the senior class, majoring in textiles, who is rated highest on the basis of scholarship, technical ability, industry, judgment, leadership, reliability, and ability to work with others.

(3) *Chemistry Department Award*

A book prize is awarded to the member of the freshman class who shows the highest achievement in Freshman Chemistry during the first semester.

(4) *National Association of Cotton Manufacturers Award*

Given to the member of the graduating class in Textile Engineering (General Manufacturing Option) or Textile Manufacturing who has maintained the highest scholastic standing throughout the four years of his undergraduate work.

(5) *Louis A. Olney Book Prizes*

Selected reference books are awarded annually to the outstanding freshman, sophomore, and junior students in the course of Textile Chemistry. The recipients are selected by the Chemistry Division chiefly on the basis of academic standing in chemical subjects.

(6) *Phi Psi Award*

Given annually to an outstanding member of the graduating class on the basis of scholastic standing, leadership, initiative, personality, loyalty, and courtesy.

(7) *President's Medal*

This award is made at Commencement to the student graduating with the most distinguished academic record in his class and *"With Highest Honors."*

(8) *Textile Veterans Association Honor Award*

This Association, representing all the veterans of World War II now affiliated with the textile and allied industries, has established an annual honor award, in the form of a suitably engraved bronze medallion. It is given to an outstanding graduating senior in a textile course on the basis of scholastic standing, extra-curricular activities, and over-all contribution to the Institute. Preference is given to veterans.

(9) *The Dean's Key*

This award, sponsored by the Student Council, is made annually to the member of the senior class who, in the eyes of a committee selected by the Dean of Students and composed of faculty and administrative personnel, has made the greatest extra-curricular contribution to the Institute during his four years of college.

STUDENT EXPENSES

The various student expenses described in this section apply only to the regular day school of Lowell Technological Institute. The fees and expenses of the Evening Division are described in a separate bulletin. All fees are established by the Board of Trustees and are subject to change without advance notice.

Payment of tuition and fees is an integral part of the registration process which must be completed before a student may attend classes. In special cases a delay in the payment of fees may be authorized, but all fees *must be paid* on or before the close of the sixth week of classes of the semester involved. Requests for delay must be approved *before* a student's registration is complete.

Application Fee (first year of registration only) . . . $10

Payable by certified check or money order and filed with the Director of Admissions at the time of application.

a. If the applicant is accepted for admission and is duly enrolled as a student at the Institute, the entire amount of this fee shall be credited toward his tuition charges on the day of registration.

b. If the applicant is not accepted for admission as a student, the entire amount of this fee shall be refunded.

c. If the applicant is accepted for admission but does not choose to enroll as a student, no refund shall be made.

d. If the applicant is accepted for admission but is called to duty in the Armed Services of the United States, he shall, upon presentation of suitable evidence of this fact, be entitled to a refund of the entire amount of the application fee.

Tuition—The yearly tuition fees are:

U. S. citizens who are residents of Massachusetts	$150
U. S. citizens who reside outside Massachusetts	$250
Citizens of other countries	$500

Students who are classified by the United States Immigration Authorities as "Displaced Persons" will pay non-residents' tuition of $250.

Applicants for admission from territorial possessions or protectorates of the United States will pay the tuition fees established for non-residents.

Special students pay, in general, the full tuition fee. However, if enrolled in only a limited number of courses, a special student may make application to the President for a reduction in tuition.

Residence

Because Lowell Technological Institute is a state-supported institution, its educational program and facilities are made available at a low tuition rate to students entering from the Commonwealth. Eligibility for admission as a resident entitled to the low residential tuition is determined under policies established by the Board of Trustees.

a. Every student claiming residence in Massachusetts must file with the Dean of Students a certificate signed by either the town or city clerk of the community claimed as legal residence, stating that the student's parents or guardian is a legal resident of the Commonwealth of Massachusetts.

b. The residence of a minor shall follow that of the parents, unless the minor has been emancipated. A minor student who has been emancipated shall, in addition to the requirements respecting residence, present satisfactory documentary evidence of emancipation.

c. A minor under guardianship shall be required to present satisfactory documentary evidence of the appointment of a guardian in addition to the certificate of residence of the guardian.

d. The residence of any applicant for admission, as shown on the application for admission at the time of initial application, shall determine the appropriate tuition charge to be made for the entire period or periods of the applicant's enrollment as an undergraduate, graduate, and/or special student.

e. The residence of a wife shall follow that of the husband.

f. The prescribed form of application for classification as to residence shall be executed by each student. Misrepresentation of facts to evade payment of the proper rate of tuition shall constitute sufficient cause for suspension or permanent separation from the Institute.

g. Payment of one-half of the total yearly tuition will be made during the registration for each semester.

h. The President of the Institute is authorized to adjust individual cases within the spirit of these rules.

Note: Wherever mentioned above, the word *residence* is considered to mean *legal domicile.*

ROTC Deposit $25

This deposit covers loss of, or damage to, uniform or equipment used for ROTC instruction. It is required of all students enrolled in ROTC. The entire amount, less charges, will be refunded upon the completion of the ROTC requirements. If, at any time, the charges against a student exceed the amount on deposit, the student will be required to pay such charges and to make an additional deposit of $25.

Activity and Insurance $40

Each student will pay $20 each semester of the academic year as a student activity and insurance fee. The payment of this fee entitles the student to free admission to all athletic events, a mailbox in the campus post office, a subscription to the student newspaper, and a copy of the yearbook. A portion of this fee helps to support the general student activities under the jurisdiction of the Student Council. It pays for the compulsory accident insurance policy which covers each student against accidents during the academic year and also contains a compulsory bonding fee which protects the Institute against unpaid student charges.

Residence Halls $275

All students, except those who live in Lowell or the surrounding community, may be required to live in one of the residence halls (see page 23 for details). The double rooms rent for $275 per student per year. One-half of the rent ($137.50) is payable at the start of each semester.

Laboratory and Materials Fee

To cover the cost of materials and normal breakage in all laboratories, each student will be charged as follows:

All freshmen	$12/semester
Upperclassmen enrolled in:	
(a) Textile Manufacturing, Textile Engineering, Textile Sales, General Engineering, or Electronic Engineering .	$12/semester
(b) Paper, Leather, or Plastics Engineering	$17/semester
(c) Textile Chemistry	$22/semester

The above charges are not refundable. Excess breakage will be billed direct to the student. These fees are payable each semester regardless of the number of laboratories taken and represent an average flat charge per semester for the regular four-year program in each of the above courses.

The above fee must be paid before a student can be admitted to laboratory work.

Commencement Fee (Seniors only) $15

This covers commencement expenses such as degree and case, rental of cap and gown, invitations, printing and other incidentals.

Late Registration Fee $5

Any student who does not complete his registration (including the payment of all fees) by the close of the registration period may be required to pay an additional fee of $5.

Official Transcript Fee $1/copy

Each student will be allowed free of charge a total of three transcripts of his scholastic record. A charge of $1 per copy will be made for each *additional* transcript.

Auditing Fee . . . . $5/credit hour

All students regularly enrolled and paying the full tuition charge in any semester may audit courses in that semester without charge providing proper approval is obtained.

Students not regularly enrolled or not paying the full tuition charge for the semester must pay $5 per credit hour to audit a course and must obtain proper approval.

Books and Materials—Students must provide their own books, stationery, tools, etc., and pay for any breakage or damage that they cause to machines, laboratory equipment, and other property of Lowell Technological Institute.

All raw stock and yarn furnished to the students, and all the productions of the Institute, remain or become its property, except by special arrangement, but each student is allowed to retain specimens of yarn or fabrics that he has produced, if mounted and tabulated in accordance with the requirements of the department. It is understood that the departments may retain such specimens of students' work as they may determine.

No books, instruments, or other property of the Institute loaned to the students are to be removed from the premises except by special permission.

Refund Schedule—Applications for refunds, filed with the Bursar on withdrawal, will be made in accordance with the following table:

No. of Weeks		*Refund*
At least	*But less than*	*Rate*
0	2	80%
2	3	60%
3	4	40%
4	5	20%
5 and over		None

Summary of Expenses Per Year

Tuition (residents of Massachusetts)	$150
Tuition (resident of other states and U. S. Possessions)	250
Tuition (residents of other countries)	500
Dormitory rate	275
Laboratory and Materials Fee	
(a) All freshmen	24
(b) Upperclassmen enrolled in:	
Textile Manufacturing, Textile Engineering, Textile Sales, General Engineering, or Electronic Engineering	24
Paper, Leather, or Plastics Engineering	34
Textile Chemistry	44
Student Activity and Insurance Fee	40
ROTC Deposit	25
*Books and supplies	50

*Books and supplies for the first year cost about $80, second and third year $35, and fourth year $50, thus averaging about $50 per year for the four years.

STUDENT ACTIVITIES

Lowell Technological Institute believes that sound educational practice seeks to develop the whole personality of the student. Accordingly, Faculty and Administration encourage extra-curricular activities and support the development of a varied and well-rounded program of activities to supplement the purely academic phase of undergraduate life. This program provides opportunity for participation in formal and informal sports, in class and campus self-government, and in the many clubs and special interest activities which appeal to the varied interests of the student body.

Student Council

The Student Council is the chief body for the conduct of self-government in student affairs. It is composed of four officers elected at large by the student body, the president of each undergraduate class, and one representative from each of the classes.

By virtue of its function as chief governing body for student affairs, it exercises administrative control over all campus organizations formed under its supervision; represents the student body in matters requiring conference with the Administration and Faculty; investigates grievances submitted by students or student groups; sponsors all-campus dances, banquets, and other social affairs; and supervises the expenditure of the unallocated portion of the Student Activity Fee. It functions in accordance with the specific prescriptions of its Constitution and By-Laws.

Arnold Air Society

The purpose of the Arnold Air Society is to unite selected advanced AFROTC cadets by a fraternal bond in order to further the mission and traditions of the Air Force. The Society is affiliated with the Air Force Association which further extends the fraternal bond to include air-minded individuals. A squadron of the Arnold Air Society has been established at this Institute and is a chapter of the National Society. The Society is responsible for a cadet sports program and a variety of social affairs during the academic year. The Military Week End, the Society's social highlight, features a colorful drill ceremony and has as its climax the formal Military Ball at which announcement of the Cadet Officers is made.

Athletics

The Athletic Association promotes an extensive varsity and intramural sports program. All students are members of the Athletic

Association and receive free admission to all intercollegiate contests played at home.

Soccer, Basketball and Baseball are varsity sports at the Institute. Competition is chiefly with teams in the northeast portion of the country. Lacrosse, Golf, Tennis and Ski Teams also compete regularly with other colleges in the area.

Intramural sports are sponsored by the Director of Intramural Athletics with an interesting year-long program of both league and informal competition between the classes, residence halls and fraternities.

Band

The AFROTC Band is composed primarily of cadets who are musicians or who desire to learn to play a band instrument. In addition to providing the music for the AFROTC ceremonies, the band adds considerably to the color and life of the campus by participating in various Institute and civic programs.

Circle K

The Circle K club is the student chapter of the Kiwanis at the Institute. In addition to performing many services in the public interest, they assist the administration of the Institute in running the freshman orientation program each year.

Flying Club

The Flying Club is operated on a corporate basis and is open to all students and faculty members. An aircraft is maintained at a local airport for purposes of instruction and solo flights for qualified members. All AFROTC members who solo successfully are awarded AFROTC wings.

Fraternities

The Interfraternity Council fosters the common interests of the four fraternity chapters at the Institute. This organization sponsors joint social and athletic contests among the fraternities.

The four fraternities have their own houses for fraternity socials and meetings, providing centers for the social life off the campus. The fraternities are: Delta Kappa Phi, Omicron Pi, Phi Psi, and Pi Lambda Phi.

International Students Circle

This club lists all foreign students at the Institute as its members. It serves to bring into close contact all these students who

may have some difficulty in becoming adjusted to a new language or way of living. These students are in demand by local civic groups to serve as speakers on many programs.

The Nucleus

The club was initiated to serve as a focal point for students to meet and present ideas and reports regarding actual activities in industry. The club has a membership limit of 15 members who are the leaders of all the major activities on the campus. A high scholastic rating is also a prime requisite for active participation.

"Pickout"

The "Pickout" is the annual year book of the campus. Those who serve on the staff secure a valuable training in the editorial, art, and business problems involved in the production of a top-quality photo-literary history of the academic year.

Professional Societies

The following societies conduct monthly meetings at which students and outstanding speakers present technical papers and lectures. Frequent field trips to industrial plants are also made by the members. These societies include:

(1) American Association of Textile Chemists and Colorists.

(2) American Society of Mechanical Engineers, Student Chapter.

(3) Electronic Engineering Society.

(4) Engineering Society.

(5) Leather Engineering Society.

(6) Paper Engineering Society.

(7) Plastics Engineering Society.

(8) Textile Society.

Radio Station

The Radio Station (WLTI) is an all-student enterprise built and maintained by members of the Lowell Technological Institute Broadcasting Society. Programs are transmitted by a carrier current to the buildings of the campus from the station studio.

The radio station sells air time to local merchants and thus is a self-supporting organization. It provides a fine opportunity for students to learn business practices as well as broadcasting and radio techniques.

Religious Groups

Hillel. The Hillel Counsellorship was established to provide social, cultural and religious programs for the Jewish students at the Institute. Discussion groups are held weekly and brunches or dances monthly. Speakers are invited to talk on subjects of interest to the whole student body. Hillel groups, located at most of the larger colleges and universities, are sponsored by the national B'nai B'rith organization.

Iona Student Fellowship. A group composed of students and faculty members of various races and creeds who, by uniting in a common fellowship, attempt to understand the will of God through worship, study and action, and thus realize it both in personal living and in working toward a better society.

Newman Club. The Newman Club is an organization sponsored by the Catholic students at the Institute. It conducts programs of a social and religious nature.

Rifle Team

The AFROTC Rifle Team is open to all AFROTC cadets. Competent staff members train the group, with the aid of National Rifle Association members, for intercollegiate competition matches. The major match of the year is the William Randolph Hearst Trophy Match.

Scholastic Honor Society

Membership in Tau Epsilon Sigma is open to members of the Junior and Senior Classes who are elected on the basis of outstanding scholastic achievement and character.

Sorority

The Sorority Phi Sigma Rho provides a center for the social life and association of the young women enrolled in the various programs of the Institute.

T.O.C.

The Tech Orientation Committee has as its special function the introduction of the new student to college life. During Orientation Week, the first week of school for the freshmen, a series of activities is planned by T.O.C. to enable freshman class members to meet each other and to realize their responsibilities to their college.

Tech Players

All the theatrical activities of the Institute are centered around the Tech Players. For years the annual production of this group has been a high point in the social calendar.

"The Text"

"The Text" is the campus newspaper. Prepared and edited by the students, this bi-weekly publication offers excellent journalistic and business experience to those who work on its staff.

Varsity Club

This club is composed of students who have earned letters in any of the six intercollegiate sports, namely, Baseball, Basketball, Golf, Lacrosse, Soccer and Tennis. Its purpose is to help athletes academically and to foster a lasting friendship among the men participating in athletics.

FINANCIAL AID TO STUDENTS

SCHOLARSHIPS

A large number of scholarships are available to students and prospective students at Lowell Technological Institute through funds contributed by various trusts, organizations, civic bodies and industrial firms. Many of the scholarships are renewable yearly for the balance of the student's undergraduate program, provided a satisfactory scholastic average is maintained; others are only for a specified period of time.

Unless applying specifically for New England Textile Foundation scholarships whose deadline is earlier, all entering freshmen who are candidates for scholarships should make direct application to the Director of Admissions, Lowell Technological Institute, Lowell, Massachusetts before June 1 and must have completed the Scholastic Aptitude test of the College Entrance Examination Board by May 1. To arrange for this test, candidates must also make direct application to the College Entrance Examination Board, P. O. Box 592, Princeton, New Jersey, with a request to take the Scholastic Aptitude test.

Available for Freshmen and Upperclassmen

1. Alumni Association Scholarships—Lowell Technological Institute

Scholarship funds under the care of the Alumni Association make available several scholarships a year which cover tuition and miscellaneous fees. These scholarships are renewable if a satisfactory scholastic standing is maintained.

2. Berkshire Hathaway, Inc., Scholarship

A number of scholarships covering tuition and living expenses for four years are offered in Textile Engineering and Manufacturing by the Berkshire Hathaway, Inc., Providence, Rhode Island. Eligible applicants are:

a. Male employees of Berkshire Hathaway, Inc. who have had adequate secondary-school training.

b. High School graduates who are sons of present employees.

Interested students should contact the Berkshire Hathaway, Inc., 704 Hospital Trust Building, Providence 1, Rhode Island.

3. Russell L. Brown Scholarship—donated by Davis and Furber Machine Company

This scholarship is open to a student acceptable to Lowell Technological Institute who plans to enroll in the curriculum of Textile Engineering or Textile Manufacturing. Preference is given to employees and sons or grandsons of employees of Davis and Furber Machine Company. The selection is based on general scholarship, initiative, and need. The stipend is $300. The appointments are for one year only but are renewable.

4. Caron Spinning Company Scholarship

This scholarship is awarded to employees or to relatives of employees of the Caron Spinning Company and to graduates of Rochelle, Illinois High School, on the basis of general scholarship, initiative, and character. The amount of the scholarship is $1,250 each year, and it is awarded on a four-year basis provided satisfactory academic standing is maintained. Application should be made directly to Caron Spinning Company, Rochelle, Illinois.

5. A. C. Lawrence Leather Company Scholarship

The A. C. Lawrence Leather Company in Peabody, Massachusetts makes available a $500 scholarship on a one-year basis to a student in Leather Engineering at Lowell Technological Institute. Preference is given to an employee or member of an employee's family, or to a resident in a town in which the Company operates. If no eligible applicants are available, the award will be open to any member of the Leather Engineering Department on the basis of merit.

6. Leather Engineering Department Scholarships

The Leather Engineering Department has funds for several scholarships and awards under its jurisdiction which it periodically releases for scholastic aid purposes through the Institute Scholarship Committee. These funds have been made available by interested industrial firms and trade organizations. These scholarships are available to deserving students enrolled in the Leather Engineering course who need financial assistance for scholastic purposes.

7. City of Lowell Scholarships

The City of Lowell has appropriated funds to provide a total of five scholarships every two-year period. These scholarships are awarded on the basis of competitive examinations to residents of the City of Lowell, Massachusetts, who are enrolled in the freshman class at the Institute. The amount of the scholarship is $150, which is full tuition at the Institute, and it is renewable provided satisfactory scholastic grades are maintained.

8. Commonwealth of Massachusetts Scholarships

Ten scholarships of $250 each year are available for young men and women who are residents of the Commonwealth of Massachusetts and are enrolled in the freshman class at the Institute. Awards are made on the basis of competitive examinations and the scholarships are renewable provided satisfactory grades are maintained.

9. The McLaurin-Jones Company Scholarship

This scholarship is awarded annually to a member of the Tantasqua Regional High School or Ware High School graduating class, or to an employee or son of an employee of the McLaurin-Jones Company for work in the Paper Engineering Department. The scholarship for $500 is renewable from year to year for four years if a satisfactory scholastic record is maintained.

10. Mohawk Carpet Mills Textile Scholarship

A $2,000 scholarship has been made available to high school graduates or employees of the Mohawk Carpet Mills who are residents of New York State. All applicants must have applied for enrollment in one of the various textile courses at the Institute in order to be eligible. Application must be made to the Mohawk Carpet Mills, Inc., Amsterdam, New York.

11. New England Tanners Club Scholarship

This scholarship is awarded by annual vote of the New England Tanners Club and is granted to a student in Leather Engineering at Lowell Technological Institute. Preference is given to employees of the member companies of the New England Tanners Club or to their families. If no eligible applicants are available, awards will be open to others on the basis of secondary-school scholastic performance and evidence of potential leadership. The amount of the scholarship is $1,000, awarded on a one-year basis.

12. New England Textile Foundation Undergraduate Scholarships

Scholarships of $250 per year plus tuition are available by means of competitive examinations to students who qualify for entrance to Lowell Technological Institute under the terms described in the ADMISSION OF UNDERGRADUATES section of this Bulletin. These scholarships are for one year but are renewable provided a satisfactory scholastic standing is maintained. All students interested in competing for one of these awards should make application directly to the New England Textile Foundation, 31 Canal Street, Providence, Rhode Island no later than January 15. Detailed instructions and the necessary application forms will be sent to each applicant accepted for the competition.

13. Pacific Mills Worsted Division Overseers Association Scholarships

Several $150 scholarships for freshmen only are supported by the Overseers Association of the Pacific Mills Worsted Division, Lawrence, Massachusetts. The Overseers Association selects qualified candidates, who must then meet with the approval of the Institute.

14. Dr. Geoffrey R. Broughton Paper Engineering Scholarship

A scholarship prize of $100 is awarded at the beginning of the spring semester to the member of the freshman class who achieves the highest scholastic standing. The prize is made available by a number of interested companies for students enrolled in the Paper Engineering Department.

15. Salem Oil & Grease Company Scholarships

Normally, two scholarships of $500 each are available each year through the Salem Oil & Grease Company in Salem, Massachusetts which established the awards as a memorial to the late Harold T. N. Smith, a founder of the company. These are allocated to candidates enrolled in the Department of Leather Engineering depending on scholastic ability and financial need.

16. Sylvan I. Stroock, Scholarship—S. Stroock & Co., Inc.

Awards are made on the basis of scholarship, financial need, leadership, and promise of success in textile fields. The sum available for scholarship purposes is $500 per year, offered annually at the discretion of the Scholarship Committee.

17. H. Webster Thomas Memorial Scholarship—donated by the Rohm and Haas Corporation of Philadelphia, Pennsylvania

This scholarship is awarded for a four-year period to a student in Leather Engineering at Lowell Technological Institute. The amount of the scholarship is $500 per year.

18. United Elastic Corporation Scholarships

Scholarships in the amount of $250 are available through the United Elastic Corporation, Easthampton, Massachusetts.

These scholarships have been established primarily for employees of the United Elastic Corporation, or members of their families. Other residents of the communities where plants are located, however, may enter applications for consideration. Preference is given to native New Englanders and to those who agree to work summers in approved mills.

Qualifications for scholarships include good character and standing in the community, aptitude for technical training, and ability to pass entrance requirements of Lowell Technological Institute. With the approval of the United Elastic Corporation

and the Lowell Technological Institute, scholarships may be awarded to deserving upperclassmen.

Each scholarship is for a one-year period and further extension if the performance of the student during the year is satisfactory. The United Elastic Corporation will, so far as possible, furnish suitable employment to the student during the summer vacation period and following graduation.

All applications should be made through the plant nearest to the residence of the applicant. Plants are located at Easthampton, Lowell, and Littleton, Massachusetts; West Haven, Connecticut; and Stuart, Virginia.

19. Jacob Ziskind Memorial Scholarship

This scholarship was established by the employees of the Merrimack Manufacturing Company in memory of Jacob Ziskind.

Qualifications for the scholarship include good character, scholastic record, initiative and ability to pass the entrance requirements at Lowell Technological Institute. Preference in granting the scholarship is given to employees of the Merrimack Manufacturing Company or members of their immediate families residing in the Greater-Lowell area. However, other residents of Greater-Lowell may enter applications for consideration.

The Merrimack Manufacturing Company will, in so far as possible, provide suitable on-the-job training during the summer vacation period and following graduation. The scholarship provides tuition, books, supplies and such deposits as are required to enroll the student in the course selected. The scholarship is renewable provided a satisfactory scholastic record is maintained.

Available for Upperclassmen Only

1. Arthur Besse Memorial Scholarship

The scholarship is awarded by the Arthur Besse Memorial Trust to a student majoring in Woolen and Worsted Manufacturing and planning to continue in that industry after graduation. Awards are based on need, scholarship, and qualities of character and leadership. The amount of the scholarship is $500 a year, and is renewable if a satisfactory scholastic record is maintained.

2. Boston Paper Trade Association Scholarship

This scholarship is open to any sophomore, junior, or senior enrolled in the Paper Engineering Department who is a resident of New England. It is awarded on the basis of scholarship and general character. The amount of the scholarship is $150. It is anticipated that the scholarship will be made renewable each year by the Association.

3. Burlington Industries Foundation Scholarship

One of the newly instituted Burlington Industries Foundation scholarships will be available at the Institute for the first time in connection with the 1956-1957 academic year. It is valued at $1000, payable $500 a year for the junior and senior years of the student selected by the Institute on the basis of his leadership, scholarship and financial need.

4. Fiberglas Scholarship—Owens-Corning Fiberglas Corporation

This scholarship is awarded annually to an outstanding sophomore in any of the textile courses. It pays the recipient full tuition and $500 per academic year for each of the junior and senior years. Selection is based upon academic record, character, qualities of leadership, and need.

5. The Gehring Foundation Memorial Scholarships—in memory of Henry G. Gehring and his son, Edward H. Gehring, both of whom were engaged in the Lace Industry.

These scholarships are made possible as a result of the Gehring Memorial Foundation of New York. Selection of recipients made by the Scholarship Committee may be reviewed by the Gehring Foundation. The amount of the scholarship is $75 per semester and is renewable if a satisfactory scholastic record is maintained.

6. Ralph E. Hale Scholarship

This scholarship was established by the Northern New England Section of the American Association of Textile Chemists and Colorists in memory of Ralph E. Hale, 1951 Chairman-elect of the Section and a 1931 graduate of L.T.I. This scholarship is awarded annually to a student at the completion of the junior year in the course in Textile Chemistry. The amount of the scholarship is $250 per year.

7. Interchemical Corporation Scholarships

Two $250 scholarships have been made available by the Interchemical Corporation of Pawtucket, Rhode Island, upon completion of two years of undergraduate work at Lowell Technological Institute. They are awarded on the basis of scholastic achievement, character, and leadership potential. Preference is given to Textile Chemistry majors.

8. New England Paper Merchants Association Scholarships

Two scholarships are open to any sophomores, juniors or seniors in the Paper Engineering Department who are residents of New England. They are awarded on the basis of scholarship and general character. The amount of each is $150. It is anticipated that they will be made renewable each year by the Association.

9. Dr. Geoffrey R. Broughton Paper Engineering Scholarships

Three prizes of $100 each are awarded at the beginning of each fall semester to the top ranking students enrolled in each of the sophomore, junior and senior classes of Paper Engineering.

Three prizes of $100 each are awarded at the beginning of each spring semester on the same basis. These prizes were made available by a number of interested companies for students enrolled in the Paper Engineering Department.

LOAN FUND

A loan fund is available for the purpose of assisting upperclassmen to continue their education at Lowell Technological Institute. Students may make application for a loan through the Faculty Treasurer of the Lowell Textile Associates, Incorporated.

Repayments on any loan which are made while the student is still in school are interest free. Loans repaid after the student leaves school (for whatever reason) bear 4% interest beginning three months after the date on which the student officially leaves school. Repayments are not required until the student separates from Lowell Technological Institute, at which time repayments are due quarterly at a rate of $10 per quarter the first year and $20 per quarter each year thereafter until the loan is repaid. Additional payments may be made at any time so as to reduce indebtedness at a more rapid rate.

FELLOWSHIPS

A number of fellowships are available to students pursuing graduate studies.

1. Teaching Fellowships

Each year Lowell Technological Institute has available through the Commonwealth of Massachusetts, a limited number of teaching fellowships for qualified students in the Graduate School who are working toward the Master of Science degree in Textile Chemistry or Textile Engineering. Appointees normally carry a half-time study load and are required to spend 12 to 15 hours per week in the supervision of undergraduate laboratories and review sections. The annual stipend is about $1500 with reappointment for a second year contingent on satisfactory performance of duties. Application forms may be obtained from and must be filed prior to April 30 with the Director of Graduate School at Lowell Technological Institute. Appointments will be made June 1 for the next academic year.

2. Research Fellowships

A limited number of Research Fellowships are also available to qualified graduate students through the Celanese Corporation of America, Linde Air Products Company, and National Aniline. These fellowships are principally in the Division of Chemistry for students who are working toward the Master of Science degree in Textile Chemistry. Research under these fellowships may involve either fundamental or applied chemistry. Appointees are expected to devote full time to study and research. The stipends are $1200-$1500 per year. Application forms may be obtained from and must be filed prior to April 30 with the Director of Graduate School at Lowell Technological Institute. Appointments will be made June 1 for the next academic year.

3. Coats and Clark Inc. Fellowship

This fellowship is available only to graduates of textile colleges. It is made available for graduate work at the Massachusetts Institute of Technology and pays approximately $700 per year plus tuition. Application should be made directly to M.I.T.

THE AIR FORCE ROTC UNIT

An Air Force Reserve Officers Training Corps unit was established at the Lowell Technological Institute on July 1, 1951. Instruction began with the opening of the first semester of the academic year 1951-52.

By vote of the Board of Trustees, all able-bodied non-veteran male students enrolling in Lowell Technological Institute for the first time on or after September 13, 1951 must satisfactorily complete the basic ROTC work (freshman and sophomore years) before receiving a Bachelor of Science degree. The President of the Institute may waive this requirement and permit the substitution of an equivalent amount of work only for those individuals who are not liable to military service under existing laws and regulations (for example, not a citizen of the United States, previous military service, etc.).

Uniforms and all equipment and textbooks required for the ROTC work will be supplied by the United States Air Force. Students in the Advanced Course will receive the standard cash payment allowed by the Air Force in lieu of subsistence.

Mission

The mission of the AFROTC unit is to develop in each cadet those attributes essential to his progressive advancement to a commission as a Second Lieutenant in the United States Air Force Reserve and further, to prepare him to fill positions of increasing responsibility as a commissioned officer in such duties in the Air Force as may be required by the national defense effort.

The AFROTC program takes into consideration the fact that many of the academic subjects in which Institute students are enrolled have as much direct relationship to military duties as they have to a civilian career. The courses contained in the AFROTC curriculum have been carefully selected to augment those academic subjects. The purpose of this course of instruction, then, is to enhance the otherwise high qualifications of the student with a thorough Air Force background.

Basic Course

The work covered in the first two years is considered the Basic Course. In addition to exercises in Leadership and Drill, this work includes classroom instruction in the Airplane and the Air Age, and the Elements and Potentials of Air Power. As stated above, the satisfactory completion of the Basic Course is a requirement for the Bachelor of Science degree in all courses offered at the

Institute. Cadets who satisfactorily complete the Basic Course may apply for the Advanced Course subject to approval by the Selection Board.

Advanced Course

The Advanced Course, consisting of the last two years of Air Force ROTC instruction supplemented by a summer camp, is designed to develop in the student to the highest degree possible those understandings, attitudes, skills and attributes of leadership considered essential in the development of all Air Force commissioned officers.

Air Science III, taught during the student's junior year, analyzes such problems as command and staff concepts; leadership laboratory; problem-solving techniques; communications process; principles and techniques of learning and teaching; Air Force correspondence and publications; military law and courts, and boards; applied air science, including aerial navigation, weather, and functions of the Air Force Base.

Air Science IV, taught during the student's senior year, contains a review of the previous years of air science; a critique of the Summer Camp training; leadership and management; military aspects of world political geography; principles of management; military aviation and the art of war; career guidance; and briefing for commissioned service.

Normally, students who successfully complete the Advanced Course are commissioned as second lieutenants in the United States Air Force Reserve and subsequently receive training as pilots or aerial observers. A limited number of students who show outstanding capability in non-flying engineering skills are also awarded commissions.

Summer Camp

In addition to completing satisfactorily the subjects required in the above generalized curriculum, each cadet enrolled in the Advanced Course is required to supplement his training by attending a summer camp of approximately four weeks duration. Usually this camp is attended during the summer preceding his senior year. Transportation from the legal residence of the cadet to the camp and return, uniforms, food, lodging, and medical and dental care are provided by the Air Force and, in addition, the cadet receives the pay of a basic airman.

Field Trips

Periodically, the Department of Air Science conducts field trips to various Air Force installations for the purpose of orientation. These trips include tours of the base and familiarization flights.

Efforts are made also to assist those cadets who are interested in flying to gain as much information as possible about the operational phase of the Air Force.

Veterans

A veteran who qualifies for and completes successfully the Advanced Course of AFROTC will be commissioned a second lieutenant in the Air Force Reserve. Under present Air Force regulations, there is no requirement for an active duty tour; however, a veteran AFROTC graduate may apply for active duty as an officer. The Professor of Air Science may waive, in consideration of military service, portions of the Basic Course which cannot be completed prior to entrance into the Advanced Course.

Contributions to Student Life

In addition to the military and academic phases of its program, the Department of Air Science sponsors various extra-curricular activities which are designed to produce a well-rounded cadet. Much of this activity is undertaken by the Arnold Air Society.

Cadet Decorations and Awards

A number of medals are awarded to selected cadets and cadet officers at a special Parade and Review held each spring.

Air Force Association Medal—Awarded to the oustanding cadet of the senior class on the basis of his military record for the entire four years of the ROTC program.

Alumni Association Medal—Awarded to the most outstanding cadet, regardless of class, for exemplary achievements in academic, military, and extra-curricular activities. This medal is given by the Lowell Technological Institute Alumni Association.

Distinguished Commander Medal—Awarded to a cadet holding the rank of Major or higher for outstanding performance.

Distinguished Squadron Commander Medal—Awarded to a cadet holding the rank of Captain or higher for outstanding performance in leadership and drill.

Distinguished Flight Leader Medals—Awarded to two cadet lieutenants for outstanding performance in leadership and drill.

Distinguished Non-Commissioned Officer Medals—Awarded to the three cadet non-commissioned officers who have distinguished themselves by their excellence in leadership and drill.

Distinguished Cadet Medals—Awarded to the three cadets of the second-year Basic Course who have distinguished themselves through their work in leadership and drill.

In addition to the above medals all cadets are eligible to compete for the following:

Arnold Air Society Scholarship—A scholarship of $100 is awarded periodically to a selected member of one of the Arnold Air Society Squadrons in the First District. The basis for selection is the financial need of the cadet coupled with his academic and military record.

Distinguished Military Graduate—Each year certain AFROTC graduates are selected to receive this honor. The bases of selection are:

(a) Qualities of military leadership.

(b) High moral character.

(c) Aptitude for military service.

(d) Excellence in academic standing and/or outstanding leadership in campus activities.

A Distinguished Military Graduate may be offered a commission as a second lieutenant in the United States Air Force.

PLACEMENT

Industrial Training Program

The Placement Bureau with the assistance of Industry endeavors to place every qualified underclassman during the summer vacation periods in an industrial position similar to the student's major field of interest at the Institute. These training opportunities are available in chemistry, electronics, leather, paper, and textiles, and are open to all students who have completed their sophomore year except those on scholastic or disciplinary probation.

The objectives of the undergraduate Industrial Training Program are:

(1) To help supply essential industrial experience to the undergraduate;

(2) To provide experience in human engineering only obtained in Industry;

(3) To furnish an employment pool enabling industry to preview individual students;

(4) To further the liaison between the Institute and Industry.

Placement Service

The Placement Bureau maintains active contacts with a number of industrial firms throughout the country in each of the fields of engineering presented at the Institute. A complete file of opportunities and data on various industries and companies is available to the members of the graduating class in the Placement Office.

The Placement Bureau arranges for the visits of representatives from industrial firms to interview students. A series of industrial seminars is conducted in which industrial speakers outline opportunities in particular industries and the various positions within the companies.

In addition to assisting in the placement of graduating students, it also assists industry in the difficult job of locating trained and experienced personnel. The office also assists Alumni to establish new connections.

The Placement Office, of course, cannot give any graduate a guarantee of employment; however, during the past year the Placement Bureau listed several jobs for every graduate and practically all seniors were placed before Commencement. No official part-time placement program is in operation because of the heavy academic schedule.

COOPERATIVE PLAN

Massachusetts Institute of Technology—
Lowell Technological Institute

A cooperative arrangement between Lowell Technological Institute and Massachusetts Institute of Technology includes the following major provisions:

(1) The mutual use of the manufacturing and research facilities for graduate and undergraduate theses;
(2) The mutual use of textile libraries of both institutions;
(3) The opportunity for students at each institute to supplement their work by taking work presented at the other institute, and summer programs of instruction;
(4) The formation of joint seminars and the interchange of staff members for special lectures;
(5) Frequent student visits and joint meetings of student societies.

SPECIAL SERVICES OF L.T.I. TO INDUSTRY AND THE COMMUNITY

In addition to the services rendered by the Evening Division, the Alumni Memorial Library, the Research Foundation, and the Summer School program, the college provides such special services to industry and to the community as the following:

Industrial seminars, conferences, and radio programs;

Guidance work in the high schools;

Consultive opportunities with the Faculty;

Collaboration with the Foreign Operations Administration of the Government by showing foreign visitors facilities and by counsel;

Special radio and television programs;

Participation in state-wide and nation-wide exhibits and programs and in community projects.

For information relative to these programs, address The Coordinator of Special Services, Lowell Technological Institute, 1 Textile Avenue, Lowell, Massachusetts.

Paper and Leather Building

In Leather Engineering Laboratory

Freshman Chemistry Laboratory

Future Paper Engineers at Work

Cumnock Hall — Newest Campus Building

Southwick Hall — Oldest Campus Building


Alumni Memorial Library at Night


At Study in the Library

Wool Finishing Equipment

Worsted System Yarn Processing Laboratory

Lacrosse

LTI AFROTC Cadet on Field Trip

SUMMER SESSION

The Summer Session is designed primarily to serve three principal areas of interest: Professional Advancement Courses for industrial personnel and home economists; Undergraduate Credit Courses for college students with course deficiencies; and Pre-College Refresher Courses for incoming freshmen at L.T.I.

The industry-sponsored professional advancement program comprises a series of specialized, intensive, one- to three-week courses in textile, paper, and leather technology. The six-week undergraduate credit program stresses fundamental courses in college mathematics, physics, chemistry, English, and economics.

Pre-College Refresher Courses

The pre-college refresher program is especially designed to articulate the high-school training of prospective L.T.I. students with the more intensive college-level studies in basic mathematics, physics, chemistry, and English. The non-credit refresher courses are offered both in a six-week and a four-week session in order to provide adequate coverage for a number of minor deficiencies in the high-school background.

For further information on the Summer Session, write to Professor Ernest P. James, Director of Summer School.

EVENING DIVISION

The Evening Division offers a wide variety of courses in engineering, chemistry, textiles, rubber, paper, leather, electronics, plastics, the social sciences, and art. These courses are designed to fit the needs of the community, particularly those people engaged in industry who wish to further their education.

The Evening Division does not grant degrees, but some courses carry credits which may be transferred toward the B.S. or M.S. degrees in the day curriculum.

Two semesters of 15 weeks each are offered, starting late in September and late in January. For further information concerning the Evening Division, write to Professor Charles L. Daley, Director of the Evening Division.

THE GRADUATE SCHOOL

By act of the General Court of 1935, authority was given to Lowell Technological Institute to confer degrees of Master of Science in Textile Chemistry, Master of Science in Textile Engineering, and Master of Science in Textile Manufacturing to graduate students who satisfactorily complete a program of advanced standing. Recently, authority has been granted to include Master of Science work in Paper Engineering, Electronic Engineering, and Leather Engineering which will lead to corresponding degrees.

The graduate programs of study offered by the Institute provide for advanced specialized training required by technologists who contribute to industrial progress and human welfare through the application of scientific and engineering principles to existing industrial and human problems. The courses of study allow the graduate of the Institute or of other colleges training men in textile, paper, or leather technology to broaden his knowledge and skills in these areas and to develop a sound research approach to problems in the basic sciences, the development of new products, and industrial production.

Inquiries concerning graduate studies should be addressed to the Director of the Graduate School.

I. Admission to the Graduate School

A. *General Admission*

To be eligible for admission to the Graduate School, an applicant must have received a Bachelor's degree in an acceptable four-year course in which he has maintained a uniformly high scholastic rating. Both quality and quantity of the previous training will be considered. Selection of those applicants admitted will be based as far as possible on their ability to pursue graduate work of high quality.

B. *Special Student Status*

An applicant who meets the general admission requirements, but who wishes to concentrate on certain subjects in specialized techniques, or in some cases on special research programs, may request to be considered for Special Student Status. This work does not lead to a degree.

Acceptance as a special student is contingent upon the consent of the instructor in charge of each subject to which admission is desired.

C. *As a Provisional Graduate Student*

An applicant for admission to the Graduate School who is unable to meet all the requirements specified in (A) may be accepted provisionally, if he satisfies the department in which he wishes to enroll that he is probably able to pursue graduate studies successfully.

The status of such a student will be changed to that of a graduate student upon demonstration of his ability to pursue graduate studies successfully as measured by the completion of his first semester's work with an average rating of at least 2.5 (80%).

D. *Application Procedure*

Those wishing to carry on graduate studies at this Institute should file application with the Director of the Graduate School. Applications may be obtained from the Office of the Graduate School.

Applications for admission should be complete and accurate and must be received not later than the first of June preceding the fall term in which the applicant wishes to enroll. Applications must be supported by letters from at least two persons qualified to judge the ability of the applicant to carry on graduate work and research. The letters should be sent directly from these persons to the Graduate School.

Transcripts of all undergraduate records (and graduate, if any) must be sent directly to the Office of the Graduate School by the institutions which the applicant has previously attended. All transcripts must be official, with appropriate seals and signatures. Records, descriptions of subjects, and letters must be in English. Each subject must be described in terms of content, scope, number of hours per week, and number of weeks duration. Lecture and laboratory time should be properly distinguished. If a catalogue giving such descriptions in English is available, the subjects taken may be clearly marked in a copy sent to the Graduate School.

A reading and speaking knowledge of English is necessary for an applicant to be considered for acceptance. Most of the subjects are presented in lecture form, making it difficult for those who do not have a reasonably fluent command of the English language.

Except in unusual circumstances, applications will be acted upon and the applicant notified of the decision by July 1. Foreign applicants are urged to make application as early as possible so as to leave enough time for visa and other arrangements to be made.

II. Graduate Courses Offered

Graduate programs are offered in the fields of textile chemistry, textile engineering and paper engineering.

Because of the varied objectives of the graduate student, the course of study is arrived at through consultation with the student's graduate adviser.

Subjects numbered 500 and above are offered for graduate credit. A limited number of undergraduate subjects are available for graduate credit. The choice of these undergraduate subjects with graduate credit is subject to the approval of the Department Head.

Each program will include an original thesis.

TEXTILE CHEMISTRY

Graduate work in Textile Chemistry allows qualified students the opportunity to pursue advanced study in the physical chemistry of textile processing such as dyeing, wet finishing and fiber modification. Studies on the organic chemistry of dyes may also be undertaken.

Recent studies have been on the theories of dyeing of natural and synthetic fibers and the application of synthetic finishes.

Such studies are carried out by graduate class work, seminars, and original theses.

The following subjects must be included in the student's program:

First Semester:

CH 503 Interpretation of Data
CH 505 Physical Chemistry of Dyeing
CH 531 Textile Chemistry Seminar

Second Semester:

CH 512 Physical Chemistry of Surface-Active Agents
CH 516 Chemical Thermodynamics
CH 532 Textile Chemistry Seminar

Other subjects of his own selection are to be added to give a suitable program.

TEXTILE ENGINEERING

Graduate work in Textile Engineering is offered so that qualified students who have completed one of the courses in Textile Engineering at Lowell Technological Institute may undertake advanced studies concerning the physical properties of textile materials and modern methods of evaluating them.

Opportunity is also provided for engineering graduates of other colleges to secure fundamental knowledge of textile materials

and processing which is a co-requisite for graduate study and research in Textile Engineering.

For graduate subjects in Textile Engineering consult subject descriptions under Engineering, Mathematics, and Physics.

PAPER ENGINEERING

The graduate program in Paper Engineering is for the purpose of giving advanced work in papermaking, paper converting or allied fields.

The Paper Engineering Department will consider graduate students from three different sources:

(a) Graduates of the Lowell Technological Institute B.S. Paper Engineering course.

(b) Paper Engineering B.S. and M.S. graduates of other schools.

(c) General B.S. and M.S. Engineering graduates with no previous paper training.

Students with the backgrounds given under (a) and (b) should be able to complete the work in one academic year. Students in group (c) should be able to complete the degree requirements in two academic years.

A graduate student in Paper Engineering will take approximately 50% of his graduate subjects (including thesis) in the Paper Engineering Department. The balance may be taken as electives related to the paper field and approved by the Department.

The graduate subjects offered in this Department are:

PA 501-502	Graduate Thesis
PA 503-504	Plant Design
PA 505-506	Advanced Papermaking and Paper Converting
PA 507-508	Graduate Seminar

III. Term of Residence

Applicants with a sufficient background in their chosen field of concentration will normally require one academic year of residence to complete the requirements for the Master's degree. Those with no background will require a minimum of two years of residence.

Graduates of other colleges usually need more than one academic year to fulfill the degree requirements, even though they majored as undergraduates in their graduate field of specialization.

IV. Expenses

Tuition, fees, and other expenses for graduate students are for the most part the same as given on page 33 for undergraduate students.

Thesis-Binding Fee

All graduate students are required to pay for the expense of binding the original thesis which will be retained in the Institute Library. Certain departments will also require a bound copy of the thesis to be deposited in the department's library.

Both of these expenses must be paid at the Library prior to registering for the thesis work. The receipt obtained from the Library will allow the student to register for the subject.

V. Candidacy for a Master's Degree

Admission to the Graduate School does not indicate that the student is a candidate for the Master's degree. A student enrolled in a graduate degree program, who has established an acceptable scholarship record and has completed half of the required program, may make application to the Director of the Graduate School to become a candidate for the degree.

Application for approval of candidacy for the advanced degree must be filed after completion of one-half of the required program and not later than twelve weeks prior to the date on which the degree is to be conferred.

VI. Requirements for Graduation

To be recommended for the Master of Science degree a candidate must have fulfilled the following requirements:

(a) Completed a course of study approved by the department in which he has been enrolled. The approved course of study is to have a minimum of 30 credit hours, including thesis. A minimum of 20 credit hours is to be spent in listed subjects, and the program should have no fewer than 5 credit hours of thesis work.

(b) Completed a thesis (original research or other investigation, optional with department) approved by the department in which he has been enrolled, and successfully passed any oral or written examinations on his thesis required by the department at the time his thesis is submitted for final approval.

(c) Maintained residence for at least one academic year.

(d) Maintained an average rating of B in graduate subjects and passed all undergraduate subjects submitted for graduate credit with a grade of B or better.

UNDERGRADUATE PROGRAMS OF STUDY

Ten fields of study are open to the undergraduates. All are four years in length and lead to the degree of Bachelor of Science. These fields are:

- Electronic Engineering
- General Engineering
- Leather Engineering
- Paper Engineering
- Plastics Engineering
- Textile Chemistry
- Textile Engineering—Engineering Option
- Textile Engineering—General Manufacturing Option
- Textile Manufacturing
- Textile Sales and Management

These curricula are outlined in the following pages. They are under constant study and subject to revision whenever changes are necessary to enable the Institute better to fulfill its mission of service to Industry.

In all courses considerable work in practical industrial applications has been included in addition to the fundamental studies in the physical sciences, mathematics, and engineering. Classes in the humanities and social sciences have been woven into all curricula in a conscious effort to produce graduates not only with a thorough technical training but also with the broad cultural background which marks the educated man.

THE FRESHMAN PROGRAM

The first semester of the freshman year is common to all curricula. With the start of the second semester of the first year, the student is permitted to undertake a limited amount of work in his field of specialization. However, continued emphasis is given to the fundamental studies in mathematics, physics, chemistry and humanities.

The program for all freshmen during the first semester is as follows:

Freshman Year

First Semester

*AS	101	Air Science	(2-1)2
CH	101	General Inorganic Chemistry	(4-3)4
EN	111	Engineering Graphics	(0-6)2
GS	111	English Composition	(3-0)3
†MA	101 or 103	College Mathematics	(4-0)4
†PH	101 or 103	Physics	(4-0)3
		Total credit hours	18
*Alternate:			
GS	101	World Economic Geography	(2-0)2

In addition to the preceding schedule all non-veteran men students who are physically qualified must take physical education for the whole freshman year. This subject meets one hour per week for AFROTC students and two hours per week for all others. It carries no academic credit.

Freshman Orientation

The first week's program in the fall for entering freshmen is called Freshman Week. It is devoted to facilitating the adjustment of the new student to his physical and social surroundings. Under the sponsorship of the Office of the Dean of Students, a program of meetings, lectures and conferences will be presented in order to acquaint the entering class with the traditions, customs, rules and

†Students are placed in mathematics and physics classes on the basis of previous mathematical training and tests administered early in the freshman year. Those taking MA 101 and PH 101 will be required to take additional work in summer school at the end of their freshman year in order to commence the sophomore year on an equal footing with the rest of their class.

regulations, courses of instruction, organizations, recreational activities and other facilities of Lowell Technological Institute.

All new students are required to attend the program of Freshman Orientation which carries no academic credits but is designed to make the freshman aware of his new responsibilities and to help him adjust himself to college life. It guides him in making the most efficient use of his time and talents, attempts to develop his ability to think for himself and react thoughtfully and intelligently to new ideas and viewpoints.

The Elective System

In all curricula an opportunity is afforded the student to elect subjects in addition to those required for graduation. These electives fall into two categories: technical electives and general electives.

Technical electives give the student a chance to broaden his professional knowledge by taking subjects allied to his main interest or to further his knowledge of a particular phase by taking additional work therein.

General electives are subjects offered by the Division of General Studies. They include cultural courses in the humanities or social sciences, or management courses to help fit the graduate for positions of executive responsibility. Normally all general electives taken by a student as an undergraduate must be chosen from one of the five cores listed below. However, in particular cases and with the division chairman's permission elective work may be divided between two cores.

In the Textile Manufacturing Course and the Textile Sales and Management Course, provision is also made for a Textile Fashion Option. A description of this option is given on page 93.

I. Management Core

GS 301	Economic Development of the United States	(3-0)3
GS 302	Modern Labor Problems	(3-0)3
GS 461	Personnel Management	(3-0)3
GS 463	Business Law	(3-0)3
GS 465	Management Problems	(3-0)3

II. Finance Core

GS 313	Money and Banking	(3-0)3
GS 341	Accounting — I	(3-0)3
GS 342	Accounting — II	(3-0)3
GS 468	Business Finance	(2-0)2
Elective		(3-0)3

III. Sales Core

GS 321	Marketing Principles and Practices	(3-0)3
GS 322	Marketing Principles and Practices	(3-0)3
GS 343	Principles of Selling and Advertising	(3-0)3
GS 421	Foreign Trade	(3-0)3
Elective		(3-0)3

IV. Literature Core

GS 222	Appreciation of Literature	(3-0)3
GS 232	Comparative Literature	(3-0)3
GS 473	Modern Drama	(3-0)3
GS 475	The Modern American Novel	(3-0)3
Elective		(3-0)3

V. History and Government Core

GS 223	The United States Since 1865	(3-0)3
GS 226	World History Since 1900	(3-0)3
GS 301	Economic Development of the United States	(3-0)3
GS 469	Comparative Modern Governments	(3-0)3
GS 471	American Foreign Policy, 1774 to the Present	(3-0)3

Electronic Engineering

The objective of the curriculum in Electronic Engineering is to provide the student with a sound foundation for a professional career in electronics. Toward this end he is given a thorough grounding in electronic science and engineering together with an intensive training in mathematics and physics.

In all courses in electronics and physics the techniques of experimental science and technology are emphasized by investigative work in the laboratory and lecture demonstrations in the classroom.

Studies in the humanities and social sciences form an important part of the program since these subjects broaden the student's outlook. They also serve to focus attention on the importance of non-technical knowledge in determining the student's ultimate level of responsibility in professional life. Emphasis is placed on the development of the student's ability to speak and write effectively so that he can express his thoughts and the results of his experimental investigations with clarity.

In addition to his formal studies, the student is encouraged and expected to do independent reading in philosophy, history and literature, as well as supplementary work in the areas of his special technical interest.

During each semester of the undergraduate program in Electronic Engineering a case study is made of some novel topic or situation occurring in industry or in the course of an engineer's professional work. This gives the student an opportunity to develop his ability to make reasoned judgments in complex situations wherein non-technical factors frequently are of paramount importance.

Due to limitations of staff and facilities, only a limited number of students can be accepted in the second semester of the freshman program in Electronic Engineering. Such acceptance is based upon the student's performance in mathematics and physics during the first semester of the freshman year. Past experience has shown that a poor performance in these subjects almost inevitably leads to failure in the dependent subjects of the second semester.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science	(2-1)2
CH	102	General Inorganic Chemistry	(4-3)4
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(2-2)3
EL	102	College Mathematics	(5-0)5
EL	104	Physics	(5-0)5
		Total credit hours	20

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
CH	331	Physical Chemistry	(3-1½)4
EL	201	Introductory Circuit Theory	(3-0)3
EL	203	Elementary Electricity and Magnetism Laboratory	(0-3)1
EL	205	Intermediate Engineering Physics	(3-0)3
EL	207	Intermediate Engineering Mathematics	(3-0)3
GS		General Elective	(3-0)3
		Total credit hours	19

*Alternate: General Elective

Second Semester

*AS	202	Air Science	(2-1)2
CH	332	Physical Chemistry	(3-3)4
EL	202	Introductory Circuit Theory	(3-0)3
EL	204	Elementary Electricity and Magnetism Laboratory	(0-3)1
EL	206	Intermediate Engineering Physics	(3-0)3
EL	208	Differential Equations for Engineers	(3-0)3
GS		General Elective	(3-0)3
		Total credit hours	19

*Alternate: General Elective

JUNIOR YEAR

First Semester

EL	301	Introduction to Physical Electronics	(3-0)3
EL	303	Electronic Circuits	(3-0)3
EL	305	Electronics Laboratory	(0-4)2
EL	307	Electromagnetic Devices and Machinery	(3-0)3
EL	309	Instrumentation and Electromagnetics Laboratory	(0-4)2
EL	311	Advanced Calculus for Engineers	(3-0)3
*AS	301	(Air Science) or General Elective	3 or 4
		Total credit hours	19 or 20

Second Semester

EL	302	Introduction to Physical Electronics	(3-0)3
EL	304	Electronic Circuits	(3-0)3
EL	306	Electronics Laboratory	(0-4)2
EL	308	Electromagnetic Devices and Machinery	(3-0)3
EL	310	Instrumentation and Electromagnetics Laboratory	(0-4)2
EL	312	Advanced Calculus for Engineers	(3-0)3
*AS	302	(Air Science) or General Elective	3 or 4
		Total credit hours	19 or 20

SENIOR YEAR

First Semester

EL	401	Industrial Electronics and Servomechanisms	(3-0)3
EL	403	Communication and Microwave Electronics	(3-0)3
EL	405	Introduction to Solid State Electronics	(3-0)3
EL	407	Experimental Electronic Techniques	(1-0)1
EL	409	Electronic Projects Laboratory	(0-4)2
EL	411	Applied Electronics Laboratory	(0-4)2
EL	421	Advanced Engineering Physics	(3-0)3
*AS	401	(Air Science) or General Elective	3 or 4
		Total credit hours	20 or 21

Second Semester

EL	402	Industrial Electronics and Servomechanisms	(3-0)3
EL	404	Communication and Microwave Electronics	(3-0)3
EL	406	Introduction to Solid State Electronics	(3-0)3
EL	408	Experimental Electronic Techniques	(1-0)1
EL	410	Electronic Projects Laboratory	(0-4)2
EL	412	Applied Electronics Laboratory	(0-4)2
EL	422	Advanced Engineering Physics	(3-0)3
*AS	402	(Air Science) or General Elective	3 or 4
		Total credit hours	20 or 21

NOTE: For explanation of the Elective System, see page 62.

General Engineering

In General Engineering the student may obtain the broad fundamental training in engineering and science which is demanded by modern industry. There is a rapidly growing need in modern industry for men who are versatile in their engineering capabilities, soundly trained in the fundamentals which underlie all engineering, and therefore adaptable to assignment to numerous positions in the industrial organizations of today. The curriculum, cutting across those of the conventional engineering courses, is designed to give the student a fundamental preparation for a wide variety of positions in industry. Through a suitable offering of electives in the senior year, provision is made for those students who acquire an interest in a particular career or industry.

During the first two years of the course, basic training is given in the sciences of chemistry, mathematics and physics. In the third and fourth years, engineering subjects such as applied mechanics, electronics, electrical machinery, thermodynamics, machine design, and fluid mechanics will further develop the analytical mind, the ability to solve engineering problems, and the latent capacity for creative design. Subjects in the fields of the humanities and the social sciences are included in the curriculum so that the engineer may be prepared for a position of executive responsibility.

A degree of Bachelor of Science in General Engineering is awarded upon completion of the course.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science	(2-1)2
CH	102	General Inorganic Chemistry	(4-3)4
EN	112	Engineering Graphics	(0-6)2
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(4-0)4
or			or
MA	104	College Mathematics	(5-0)5
PH	102	Physics	(3-2)4
or			or
PH	104	Physics	(5-0)5
		Total credit hours	20 or 22

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
EN	203	Mechanism	(3-0)3
EN	207	Machine Drawing	(0-6)2
EN	233	Machine Tool Laboratory	(0-3)1
GS	201	Economics	(3-0)3
MA	201	Analytic Geometry and Calculus	(4-0)4
PH	201	Physics	(3-2)4
		Total credit hours	19

*Alternate: General Elective

Second Semester

*AS	202	Air Science	(2-1)2
EN	222	Applied Mechanics	(3-0)3
EN	232	Engineering Materials	(2-3)3
GS	202	Economics	(3-0)3
MA	202	Analytic Geometry and Calculus	(3-0)3
MA	206	Differential Equations	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	21

*Alternate: General Elective

JUNIOR YEAR

First Semester

EN	301	Advanced Applied Mechanics	(3-0)3
EN	303	Electrical Circuits	(3-2)4
EN	305	Thermodynamics	(3-0)3
AS	301	(Air Science) and two Electives, or three Electives	10 or 11
		Total credit hours	20 or 21

Electives

CH	331	Physical Chemistry	(3-1½)4
EN	307	Surveying and Structures	(3-3)4
MA	301	Advanced Calculus	
		General Electives	

Second Semester

EN	302	Advanced Applied Mechanics	(3-0)3
EN	412	Heat Engineering	(3-2)4
PH	321	Electronics	(3-2)4
AS	302	(Air Science) and one Elective, or two Electives	6 to 8
		Total credit hours	17 to 19

Electives

CH	332	Physical Chemistry	(3-3)4
CH	352	Chemical Engineering	(3-0)3
EN	308	Structures	(3-0)3
MA	302	Advanced Calculus	(3-0)3
		General Electives	

SENIOR YEAR

First Semester

EN	351	Statistical Methods	(3-0)3
EN	401	Principles of Electrical Engineering	(3-2)4
GS	209	Speech	(2-0)2
GS	211	Business English	(2-0)2
AS	401	(Air Science) and one Elective, or two Electives	6 or 7
		Total credit hours	17 or 18

Electives

CH	441	Chemical Engineering	(3-0)3
EN	427	Machine Design	(2-3)3
EN	433	Manufacturing Engineering	(3-0)3
GS	341	Accounting—I	(3-0)3
PH	401	Microscopy	(2-3)3
PH	503	Spectrographic Methods	(2-2)3
PH	505	X-Ray Diffraction	(2-3)3

Second Semester

EN	406	Fluid Mechanics	(3-2)4
EN	420	Industrial Instrumentation	(2-3)3
GS	412	Industrial Management	(3-0)3
AS	402	(Air Science) and/or Electives	7 or 8
		Total credit hours	17 or 18

Electives

EN	402	Electrical Control Systems	(3-2)4
EN	428	Machine Design	(2-3)3
EN	504	Air Conditioning	(2-2)2
PH	504	Spectrographic Methods	(2-2)3
PH	508	Electron Microscopy	(1-3)2

NOTE: For explanation of the Elective System, see page 62.

Leather Engineering

The concept of a leather engineer is new to the leather industry. The economics, size, and scope of this industry warrant the careful training of individuals capable of handling its specific problems.

The leather industry realizes that many of its products can be improved by the application of sound and intelligent research and development. There is a constantly increasing demand for engineers with a thorough understanding of the art of leather manufacturing.

In this curriculum, emphasis is placed on the fundamentals of engineering including mathematics, physics, chemistry, and theoretical and applied mechanics. These subjects are basic in any sound undergraduate program. To these are added subjects in the application of basic scientific principles to leather technology.

In order properly to balance this program, subjects in general education are offered, since the engineer must be trained to be a leader not only in his profession but also in everyday economic, social and political affairs. He must also be trained to meet success, promotion, and the challenge of directing the work of others.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science	(2-1)2
CH	102	General Inorganic Chemistry	(4-3)4
EN	112	Engineering Graphics	(0-6)2
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(4-0)4
or			or
MA	104	College Mathematics	(5-0)5
PH	102	Physics	(3-2)4
or			or
PH	104	Physics	(5-0)5
		Total credit hours	19 or 21

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
CH	121	Qualitative Analysis	(2-6)4
CH	201	Organic Chemistry	(3-3)4
EN	223	Applied Mechanics	(3-0)3
MA	201	Analytic Geometry and Calculus	(4-0)4
PH	201	Physics	(3-2)4
		Total credit hours	21

*Alternate:

GS	201	Economics	(3-0)3

Second Semester

*AS	202	Air Science	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	212	Quantitative Analysis	(3-8)6
LE	202	Applied Leather Analysis	(1-4)2
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	21

*Alternate:

GS	202	Economics	(3-0)3

JUNIOR YEAR

First Semester

CH	331	Physical Chemistry	(3-1½)4
LE	301	Leather Manufacture	(3-6)5
LE	303	Leather Histology	(2-4)4
AS	301	(Air Science) and one General Elective, or two General Electives	6 or 7
		Total credit hours	19 or 20

Second Semester

CH	332	Physical Chemistry	(3-3)4
LE	302	Leather Manufacture	(3-6)5
LE	304	Advanced Leather Histology	(2-4)4
AS	302	(Air Science) and one General Elective, or two General Electives	6 or 7
		Total credit hours	19 or 20

SENIOR YEAR

First Semester

EN	351	Statistical Methods	(3-0)3
LE	401	Leather Manufacture	(3-6)5
LE	405	Leather Seminar	(1-0)1
PH	321	Electronics	(3-1)3
AS	401	(Air Science) and one General Elective, or two General Electives	6 or 7
		Total credit hours	18 or 19

Second Semester

EN	344	Electrical Machinery	(3-2)4
LE	402	Leather Manufacture	(3-6)5
LE	404	Properties of Leather	(2-3)3
LE	406	Leather Seminar	(1-0)1
AS	402	(Air Science) and one General Elective, or two General Electives	6 or 7
		Total credit hours	19 or 20

NOTE: For explanation of the Elective System, see page 62.

Paper Engineering

The object of this course is to fit a man for work in the paper-making, paper-converting, or allied industries. For this, a thorough training in basic chemical engineering is offered, accompanied by instruction in the theory and practice of pulp and paper manufacture and paper converting.

Paper engineering involves the application of cellulose and plastics chemistry together with engineering principles to the handling of the material in the web or sheet form, as it is treated, coated, or converted into the final product. Every effort is made by cooperation with local concerns to supplement college work by experience in actual manufacturing conditions, thus giving the student an opportunity to familiarize himself with equipment commonly in use in the industry.

Students taking this course should be well equipped for work in the paper-making or paper-converting fields, or for graduate study in paper technology.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science	(2-1)2
CH	102	General Inorganic Chemistry	(4-3)4
EN	112	Engineering Graphics	(0-6)2
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(4-0)4
or			or
MA	104	College Mathematics	(5-0)5
PH	102	Physics	(3-2)4
or			or
PH	104	Physics	(5-0)5
		Total credit hours	19 or 21

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
CH	201	Organic Chemistry	(3-3)4
CH	211	Quantitative Analysis	(3-8)6
MA	201	Analytic Geometry and Calculus	(4-0)4
PH	201	Physics	(3-2)4
		Total credit hours	20

*Alternate: General Elective

Second Semester

*AS	202	Air Science	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	290	Introduction to Chemical Engineering	(3-3)4
EN	224	Applied Mechanics	(3-0)3
MA	202	Analytic Geometry and Calculus	(4-0)4
PH	202	Physics	(3-2)4
		Total credit hours	21

*Alternate: General Elective

JUNIOR YEAR

First Semester

CH	331	Physical Chemistry	(3-1½)4
CH	333	Industrial Stoichiometry	(3-0)3
PA	301	Pulp Technology	(3-0)3
PA	303	Pulp Laboratory	(2-6)4
PH	321	Electronics	(3-1)3
AS	301	(Air Science) or General Elective	3 or 4
		Total credit hours	20 or 21

Second Semester

CH	332	Physical Chemistry	(3-3)4
CH	352	Chemical Engineering	(3-0)3
CH	334	General Colloid Chemistry	(3-0)3
PA	302	Paper Technology	(3-0)3
PA	304	Paper Laboratory	(2-6)4
AS	302	(Air Science) or General Elective	3 or 4
		Total credit hours	20 or 21

SENIOR YEAR

First Semester

CH	441	Chemical Engineering	(3-0)3
PA	403	Converting Technology	(3-0)3
PA	405	Converting Laboratory	(2-6)4
PA	409	Mill Inspections	(1-4)2
AS	401	(Air Science) and one General Elective, or two General Electives	6 or 7
		Total credit hours	18 or 19

Second Semester

CH	442	Chemical Engineering Thermodynamics	(3-0)3
EN	344	Electrical Machinery	(3-2)4
EN	352	Statistical Methods	(3-0)3
EN	420	Industrial Instrumentation	(2-3)3
PA	414	Paper Problems	(2-6)4
AS	402	(Air Science) or General Elective	3 or 4
		Total credit hours	20 or 21

NOTE: For explanation of the Elective System, see page 62.

Plastics Engineering

This curriculum has as its objective the training of engineers specifically prepared to cope with the many technical and production problems found in the rapidly expanding field of plastics fabrication.

The emphasis is on the engineering principles involved in the fabrication of plastic materials into useful forms rather than the chemistry involved in the manufacture of the plastic material itself. Due to the close relationship involved between the physical and chemical properties of such materials, however, the curriculum involves considerably more chemistry than most engineering courses.

A basic training in mathematics and physics is required as well as elementary and advanced engineering subjects. In the third and fourth years this basic knowledge is focused on the problems of the plastics industry, including design, manufacture and testing.

Classes in the humanities and applied economics round out the education of the plastics engineer and equip him to advance to the administrative as well as the purely technological type of position.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science	(2-1)2
CH	102	General Inorganic Chemistry	(4-3)4
EN	112	Engineering Graphics	(0-6)2
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(4-0)4
or			or
MA	104	College Mathematics	(5-0)5
PH	102	Physics	(3-2)4
or			or
PH	104	Physics	(5-0)5
		Total credit hours	19 or 21

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
CH	201	Organic Chemistry	(3-3)4
CH	205	Qualitative Analysis	(2-6)4
GS	201	Economics	(3-0)3
MA	201	Analytic Geometry and Calculus	(4-0)4
PH	201	Physics	(3-2)4
		Total credit hours	21

*Alternate: General Elective

Second Semester

*AS	202	Air Science	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	212	Quantitative Analysis	(3-8)6
GS	202	Economics	(3-0)3
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	22

*Alternate: General Elective

JUNIOR YEAR

First Semester

CH	331	Physical Chemistry	(3-1½)4
CH	375	Chemistry of High Polymers	(3-3)4
EN	122	Machine Tool Laboratory	(1-2)1
EN	325	Applied Mechanics	(3-0)3
PL	301	Introduction to Plastics Technology	(3-3)4
AS	301	(Air Science) or Elective	2 to 4
		Total credit hours	18 to 20

Second Semester

CH	332	Physical Chemistry	(3-3)4
CH	375	Chemistry of High Polymers	(3-3)4
EN	223	Machine Tool Laboratory	(0-3)1
EN	328	Strength of Materials	(3-0)3
PL	302	Plastics Technology	(3-3)4
AS	302	(Air Science) or Elective	2 to 4
		Total credit hours	18 to 20

SENIOR YEAR

First Semester

EN	351	Statistical Methods	(3-0)3
EN	405	Electronic Controls and Power Circuits	(3-2)4
PL	401	Advanced Plastics Technology	(3-6)5
PL	451	Plastics Seminar	(1-0)1
AS	401	(Air Science) and one Elective, or two Electives	5 to 7
		Total credit hours	18 to 20

Second Semester

EN	332	Engineering Materials	(2-0)2
EN	422	Industrial Instrumentation	(2-0)2
EN	508	Fluid Mechanics	(3-0)3
PL	402	Advanced Plastics Technology	(3-6)5
PL	452	Plastics Seminar	(1-0)1
AS	402	(Air Science) and one Elective, or two Electives	5 to 7
		Total credit hours	18 to 20

Technical Electives

GS	261-62	Technical German	(3-0) (3-0)6
CH	473	Theory of Atomic and Molecular Structure	(2-0)2
CH	474	Advanced Inorganic Chemistry	(2-0)2
EN	203	Mechanism	(3-0)3
EN	502	Statistical Quality Control	(3-0)3
EN	509 or 510	Advanced Statistical Methods	(3-0)3
MA	206	Differential Equations	(3-0)3

NOTE: For explanation of the Elective System, see page 62.

Textile Chemistry

This curriculum is designed to prepare a student for the profession of chemistry, specifically as applied to the textile industry or to those related segments of the chemical industry which are engaged in the production of chemicals and fibers directly or indirectly used in textiles. Because of the broad scope of training in this curriculum, the student is prepared for positions in such related fields as research, development and production, and for those particularly suited, the curriculum provides a sound technical background for careers in sales or technical service.

This curriculum provides sound basic training in chemistry and in the related sciences of physics and mathematics. Training in chemistry includes both fundamental studies in inorganic, analytical, organic and physical chemistry and applied studies in fiber and cloth preparation, dyeing, printing and finishing.

Subjects in the humanities are included in the textile chemistry curriculum in order to provide the student with the broader background which may be required of him as he advances to more responsible positions in his chosen profession and in community and national life.

Students having difficulty in color perception are advised to take positions in those branches of textile chemistry which do not include work in dyehouses, or with dyestuff concerns where such a shortcoming would prove to be a serious disadvantage.

The following curriculum is applicable to classes subsequent to the Class of 1957. The program for that class will be found in the Catalogue Issue of 1954-1955.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science	(2-1)2
CH	102	General Inorganic Chemistry	(4-3)4
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(4-0)4
or			or
MA	104	College Mathematics	(5-0)5
PH	102	Physics	(3-2)4
or			or
PH	104	Physics	(5-0)5
		Total credit hours	17 or 19
*Alternate:			
GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
CH	201	Organic Chemistry	(3-3)4
CH	211	Quantitative Analysis	(3-8)6
MA	201	Analytic Geometry and Calculus	(4-0)4
PH	201	Physics	(3-2)4
		Total credit hours	20

*Alternate: General Elective

Second Semester

*AS	202	Air Science	(2-1)2
CH	202	Organic Chemistry	(3-3)4
CH	206	Qualitative Analysis	(2-6)4
CH	252	Chemistry and Physics of Fibers	(2-3)3
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	20

*Alternate: General Elective

JUNIOR YEAR

First Semester

CH	311	Textile Quantitative Analysis	(1-3)2
CH	331	Physical Chemistry	(3-1½)4
CH	353	Chemistry of Fiber Purification	(2-3)3
GS	201	Economics	(3-0)3
TE	327	Elements of Textile Manufacture	(2-2)3
TE	403	Textile Evaluation	(2-2)3
AS	301	(Air Science) or Elective†	2 to 4
		Total credit hours	20 to 22

Second Semester

CH	322	Physical Chemistry	(3-3)4
CH	354	Organic Chemistry of Colored Substances	(2-0)2
CH	364	Textile Colloid Chemistry	(4-0)4
GS	202	Economics	(3-0)3
TE	328	Elements of Textile Manufacture	(2-2)3
TE	404	Textile Evaluation	(2-2)3
AS	302	(Air Science) or Elective†	2 to 4
		Total credit hours	21 to 23

SENIOR YEAR

First Semester

CH	453	Theory of Dyeing	(2-6)4
TE	409	Woolen and Worsted Finishing	(3-3)4
AS	401	(Air Science) and/or Electives†	10 to 12
		Total credit hours	18 to 20

Second Semester

CH	422	Chemical Textile Testing	(2-3)3
CH	454	Industrial Dyeing	(2-8)4
CH	456	Printing	(0-3)1
TE	408	Cotton and Synthetic Finishing	(3-3)4
AS	402	(Air Science) and/or Electives†	8 or 9
		Total credit hours	20 or 21

†Five electives must be chosen from one of the General Elective cores. The rest may be taken in technical subjects of advanced nature.

NOTE: For explanation of the Elective System, see page 62.

Textile Engineering

Engineering Option

A textile engineer is defined as one who has had a basic training in engineering to which has been added a knowledge of the manufacture of textiles, their properties and uses.

The Engineering Option of Textile Engineering provides a training in mechanical engineering similar to that found in other engineering schools. To this is added a knowledge of textiles sufficient to prepare the individual for positions in the textile and allied industries which may involve research and engineering principles. Business subjects and the humanities are included in the curriculum so that this type of textile engineer may have the educational potential to rise to a position of executive responsibility.

The following curriculum is applicable to the Class of 1959 and subsequent classes. The program for the Class of 1957 and the Class of 1958 will be found in the Catalogue Issue of 1954-1955.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science	(2-1)2
CH	102	General Inorganic Chemistry	(4-3)4
EN	112	Engineering Graphics	(0-6)2
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(4-0)4
or			or
MA	104	College Mathematics	(5-0)5
PH	102	Physics	(3-2)4
or			or
PH	104	Physics	(5-0)5
		Total credit hours	20 or 22

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
EN	203	Mechanism	(3-0)3
EN	207	Machine Drawing	(0-6)2
EN	233	Machine Tool Laboratory	(0-3)1
GS	201	Economics	(3-0)3
MA	201	Analytic Geometry and Calculus	(4-0)4
PH	201	Physics	(3-2)4
		Total credit hours	19

*Alternate: General Elective

Second Semester

*AS	202	Air Science	(2-1)2
EN	222	Applied Mechanics	(3-0)3
EN	232	Engineering Materials	(2-3)3
GS	202	Economics	(3-0)3
MA	202	Analytic Geometry and Calculus	(3-0)3
MA	206	Differential Equations	(3-0)3
PH	202	Physics	(3-2)4
		Total credit hours	21

*Alternate: General Elective

JUNIOR YEAR

First Semester

EN	301	Advanced Applied Mechanics	(3-0)3
EN	305	Thermodynamics	(3-0)3
EN	351	Statistical Methods	(3-0)3
PH	321	Electronics	(2-2)3
TE	327	Elements of Textile Manufacture	(3-3)4
AS	301	(Air Science) or General Elective	3 or 4
		Total credit hours	19 or 20

Second Semester

EN	302	Advanced Applied Mechanics	(3-0)3
EN	342	Principles of Electrical Engineering	(3-2)4
EN	412	Advanced Heat Engineering	(3-2)4
TE	328	Elements of Textile Manufacture	(3-3)4
AS	302	(Air Science) or General Elective	3 or 4
		Total credit hours	18 or 19

SENIOR YEAR

First Semester

EN	401	Principles of Electrical Engineering	(2-2)3
EN	431	Advanced Physical Textile Testing	(2-3)3
GS	209	Speech	(2-0)2
GS	211	Business English	(2-0)2
GS	341	Accounting—I	(3-0)3
AS	401	(Air Science) or General Elective	3 or 4
		Technical Elective	3
		Total credit hours	19 or 20

Technical Electives

EN	427	Machine Design	(2-3)3
EN	433	Manufacturing Tools and Methods	(3-0)3
PH	401	Textile Microscopy	(2-3)3
PH	503	Spectrographic Methods	(2-2)3
PH	505	X-Ray Diffraction	(2-3)3

Second Semester

EN	420	Industrial Instrumentation	(2-3)3
EN	430	Engineering Design of Textile Structures	(3-0)3
EN	508	Fluid Mechanics	(3-0)3
GS	412	Industrial Management	(3-0)3
AS	402	(Air Science) or General Elective	3 or 4
		Technical Electives	3 or 4
		Total credit hours	18 to 20

Technical Electives

EN	404	Heat Transfer	(2-0)2
EN	428	Machine Design	(2-3)3
EN	504	Air Conditioning	(2-2)2
PH	402	Textile Physics	(2-2)3
PH	504	Spectrographic Methods	(2-2)3
PH	508	Electron Microscopy	(1-3)2

NOTE: For explanation of the Elective System, see page 62.

Textile Engineering

General Manufacturing Option

It is the belief that except in highly specialized areas, e.g., chemistry, the ideal training for the textile industry combines an understanding of textile processing relating to all fibers with a sound engineering and scientific background, as well as an orientation to society and business through a selected core of liberal arts and economic subjects.

The objective of the General Manufacturing Option is to provide the textile industry with technically trained textile engineers. The curriculum has been planned so that the textile engineer (1) will be given as complete and thorough a knowledge and understanding of the raw materials, machines, and processes peculiar to the manufacture of all fibers as is possible; (2) will have a basic training in engineering and the fundamental sciences; and (3) will acquire a knowledge of business and managerial principles and the social sciences.

The first component should prepare the student to be useful in any textile plant regardless of fiber processed. The second should develop a man who will approach textile problems from an engineering viewpoint, thus contributing toward their solution the benefits of a trained analytical mind. The third objective should aid in the production of a well-rounded individual.

The following curriculum is applicable to classes subsequent to the Class of 1957. The program for that class will be found in the Catalogue Issue of 1954-1955.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science	(2-1)2
CH	102	General Inorganic Chemistry	(4-3)4
EN	112	Engineering Graphics	(0-6)2
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(4-0)4
or			or
MA	104	College Mathematics	(5-0)5
PH	102	Physics	(3-2)4
or			or
PH	104	Physics	(5-0)5
		Total credit hours	20 or 22

*Alternate:

GS	102	World Economic Geography	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
EN	201	Machine Drawing	(0-3)1
EN	203	Mechanism	(3-0)3
GS	201	Economics	(3-0)3
MA	201	Analytic Geometry and Calculus	(4-0)4
PH	201	Physics	(3-2)4
TE	203	Textile Fibers	(4-0)4
		Total credit hours	21

*Alternate: General Elective

Second Semester

*AS	202	Air Science	(2-1)2
EN	220	Textile Mechanism	(1-2)2
EN	326	Applied Mechanics	(3-0)3
GS	202	Economics	(3-0)3
MA	202	Analytic Geometry and Calculus	(3-0)3
PH	202	Physics	(3-2)4
TE	206	Yarn Manufacture	(3-3)4
		Total credit hours	21

*Alternate: General Elective

JUNIOR YEAR

First Semester

CH	203	Elementary Organic Chemistry	(3-0)3
EN	327	Strength of Materials	(3-0)3
PH	321	Electronics	(3-1)3
TE	307	Yarn Manufacture	(3-3)4
TE	309	Fabric Manufacture	(2-2)2
AS	301	(Air Science) or General Elective	3 or 4
		Total credit hours	18 or 19

Second Semester

CH	302	Introduction to Textile Chemistry	(1-3)2
EN	344	Electrical Machinery	(3-2)4
EN	352	Statistical Methods	(3-0)3
TE	308	Yarn Manufacture	(3-3)4
TE	310	Fabric Manufacture	(3-3)4
AS	302	(Air Science) or General Elective	3 or 4
		Total credit hours	20 or 21

SENIOR YEAR

First Semester

EN	403	Principles of Heat Engineering	(3-2)4
GS	341	Accounting—I	(3-0)3
TE	403	Textile Evaluation	(2-2)3
TE	405	Textile Finishing	(2-3)3
AS	401	(Air Science) or a Technical Elective, and one General Elective	6 or 7
		Total credit hours	19 or 20

Technical Electives

EN	507	Fluid Mechanics	(3-0)3
TE	407	Knitting	(2-3)3
TE	417	Cotton Mill Organization	(4-0)4

Second Semester

GS	210	Speech	(2-0)2
GS	212	Business English	(2-0)2
GS	412	Industrial Management	(3-0)3
TE	404	Textile Evaluation	(2-2)3
TE	406	Textile Finishing	(2-3)3
AS	402	(Air Science) or a Technical Elective, and one General Elective	6 or 7
		Total credit hours	19 or 20

Technical Electives

EN	420	Industrial Instrumentation	(2-3)3
EN	432	Advanced Physical Textile Testing	(2-3)3

NOTE: For explanation of the Elective System, see page 62.

Textile Manufacturing

This course of study is designed to equip students with a well-rounded understanding of the theory and principles of fundamental manufacturing processes. All common commercial fibers are studied regardless of whether they are animal, vegetable, mineral, or man-made.

This course is concerned with a detailed study of such textile topics as fiber sources, availability, properties, characteristics, uses, methods of manufacturing man-made fibers, marketing, grading, sorting, and other preparatory steps. It also covers the theory of and its application to the fundamental textile manufacturing operations, such as fiber processing, yarn manufacture, fabric design, weaving, and knitting, and finishing and testing or evaluation.

The broad purpose is to prepare students as competent textile manufacturing technologists for eventual supervisory, administrative or executive positions. It is felt that this can best be done by a comprehensive course that covers the basic theory, principles and applications of all phases of textile manufacturing with all fibers and all processes.

This course leads to a B.S. degree and hence, such fundamental studies as mathematics, physics and chemistry are naturally included. However, a maximum amount of time is devoted to textile and such engineering subjects as are essential to a textile manufacturing technologist.

The humanities are included to provide a balanced education and to develop the student's ability to express himself clearly to others, as well as to give him an understanding of human behavior.

Any student completing this course of study should be well qualified ultimately to assume a position of responsibility in any phase of the textile industry, whether it be in manufacturing, techical service, development, or research.

A Textile Fashion Option is available for women students and for men who are not enrolled in AFROTC classes. The purpose of this option is to provide interested students with the opportunity to take additional work in textile design and fashion in order to give them an understanding of the needs and operations of the fashion industry.

The following curriculum is applicable to classes subsequent to the Class of 1957. The program for that class will be found in the Catalogue Issue of 1954-1955.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science	(2-1)2
CH	102	General Inorganic Chemistry	(4-3)4
EN	112	Engineering Graphics	(0-6)2
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(4-0)4
or			or
MA	104	College Mathematics	(5-0)5
PH	102	Physics	(3-2)4
or			or
PH	104	Physics	(5-0)5
		Total credit hours	20 or 22

*Alternate:

GS	102	World Economic Geography or Textile Fashion Option	(2-0)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
CH	203	Elementary Organic Chemistry	(3-0)3
EN	205	Mechanism	(3-2)4
MA	201	Analytic Geometry and Calculus	(4-0)4
PH	201	Physics	(3-2)4
TE	201	Textile Fibers	(4-0)4
		Total credit hours	21

*Alternate:

GS	226	World History since 1900	(3-0)3
		or Textile Fashion Option	(0-5)2

Second Semester

*AS	202	Air Science	(2-1)2
EN	352	Statistical Methods	(3-0)3
PH	202	Physics	(3-2)4
PH	204	Optical Instruments	(3-2)4
TE	202	Textile Fibers	(3-0)3
TE	204	Yarn Technology	(3-6)5
		Total credit hours	21

*Alternate:

GS	210	Speech	(2-0)2
		or Textile Fashion Option	(0-5)2

JUNIOR YEAR

First Semester

EN	311	Heat and Power	(2-2)3
GS	201	Economics	(3-0)3
TE	301	Yarn Technology	(4-9)7
TE	303	Fabric Technology	(3-3)4
AS	301	(Air Science), General Elective or Textile Fashion Option	3 or 4
		Total credit hours	20 or 21

Second Semester

CH	302	Introduction to Textile Chemistry	(1-3)2
GS	202	Economics	(3-0)3
TE	302	Yarn Technology	(4-9)7
TE	304	Fabric Technology	(3-3)4
AS	302	(Air Science), General Elective or Textile Fashion Option	3 or 4
		Total credit hours	19 or 20

SENIOR YEAR

First Semester

CH	401	Introduction to Textile Chemistry	(1-3)2
GS	301	Economic Development of the United States	(3-0)3
TE	401	Fabric Technology	(4-6)6
TE	403	Textile Evaluation	(2-2)3
TE	405	Textile Finishing	(2-3)3
AS	401	(Air Science), General Elective or Textile Fashion Option	3 or 4
		Total credit hours	20 or 21

Second Semester

GS	314	Philosophy of Science	(3-0)3
EN	304	Textile and Electronic Instrumentation	(2-2)3
TE	402	Fabric Technology	(3-6)5
TE	404	Textile Evaluation	(2-2)3
TE	406	Textile Finishing	(2-3)3
AS	402	(Air Science), General Elective or Textile Fashion Option	3 or 4
		Total credit hours	20 or 21

NOTE: For explanation of the Elective System, see page 62.

TEXTILE FASHION OPTION

FRESHMAN YEAR

Second Semester

GS	122	Perspective Drawing	(1-1)1
GS	132	Freehand Drawing	(0-3)1

SOPHOMORE YEAR

First Semester

TE	211	Color	(1-1)1
TE	281	Fashion Illustration	(0-3)1

Second Semester

TE	212	Color	(1-1)1
TE	282	Fashion Illustration	(0-3)1

JUNIOR YEAR

First Semester

TE	311	Handloom Weaving	(0-3)1
TE	319	History of Costume and Adaptions	(1-2)2
TE	323	Surface Design Fundamentals	(0-2)1

Second Semester

TE	324	Applied Decorative Design	(0-2)1
TE	326	Cotton and Synthetic Design	(1-2)2
TE	352	Fabric Draping	(0-3)1

SENIOR YEAR

First Semester

TE	433	Pattern Drafting	(0-3)1
TE	435	Woolen and Worsted Design	(1-2)2
TE	437	Weaving Laboratory	(0-3)1

Second Semester

TE	442	Fashion Design and Construction	(1-4)2
TE	444	Jacquard Design	(1-2)2

Textile Sales and Management

This course is designed for those interested in the marketing and management phases of the textile and allied industries. Its emphasis is on all three branches of management—production, distribution, and finance.

The student is given a fundamental knowledge of the natural sciences and their application to the processing of all types of textile fibers. This scientific and manufacturing background is increasingly essential to effective merchandising and management, particularly at the higher levels of supervision.

A substantial amount of time is also devoted to cultural subjects designed to broaden the student's outlook, increase his understanding of social and economic problems, and improve his ability to get along with people.

A Textile Fashion Option is available for women students and for men who are not enrolled in AFROTC training. Details will be found in the description of the Textile Manufacturing curriculum.

The following curriculum applies to classes subsequent to the Class of 1957. The program for that class will be found in the Catalogue Issue of 1954-1955.

FRESHMAN YEAR

First Semester

Refer to section headed "Freshman Program"

Second Semester

*AS	102	Air Science	(2-1)2
CH	102	General Inorganic Chemistry	(4-3)4
EN	112	Engineering Graphics	(0-6)2
EN	122	Machine Tool Laboratory	(1-2)1
GS	112	English Composition and Readings	(3-0)3
MA	102	College Mathematics	(4-0)4
or			or
MA	104	College Mathematics	(5-0)5
PH	102	Physics	(3-2)4
or			or
PH	104	Physics	(5-0)5
		Total credit hours	20 or 22

*Alternate:

GS	102	World Economic Geography	(2-0)2
		or	
		Textile Fashion Option†	(1-4)2

SOPHOMORE YEAR

First Semester

*AS	201	Air Science	(2-1)2
CH	203	Elementary Organic Chemistry	(3-0)3
GS	201	Economics	(3-0)3
MA	201	Analytic Geometry and Calculus	(4-0)4
PH	201	Physics	(3-2)4
TE	203	Textile Fibers	(4-0)4
		Total credit hours	20

*Alternate:

Elective approved by Division Head†

Second Semester

*AS	202	Air Science	(2-1)2
EN	352	Statistical Methods	(3-0)3
GS	202	Economics	(3-0)3
GS	206	Man and His Environment	(3-0)3
PH	202	Physics	(3-2)4
TE	206	Yarn Manufacture	(3-3)4
		Total credit hours	19

*Alternate:

Elective approved by Division Head†

JUNIOR YEAR

First Semester

GS	311	Economic Statistics	(3-0)3
GS	321	Marketing Principles and Practices	(3-0)3
GS	341	Accounting—I	(3-0)3
TE	307	Yarn Manufacture	(3-3)4
TE	309	Fabric Manufacture	(2-2)2
AS	301	(Air Science) or Elective approved by Division Head†	3 or 4
		Total credit hours	18 or 19

Second Semester

CH	302	Introduction to Textile Chemistry	(1-3)2
GS	322	Marketing Principles and Practices	(3-0)3
GS	342	Accounting—II	(3-0)3
TE	308	Yarn Manufacture	(3-3)4
TE	310	Fabric Manufacture	(3-3)4
AS	302	(Air Science) or Elective approved by Division Head†	3 or 4
		Total credit hours	19 or 20

SENIOR YEAR

First Semester

GS	303	Psychology	(3-0)3
GS	343	Principles of Selling and Advertising	(3-0)3
GS	461	Personnel Management	(3-0)3
GS	463	Business Law	(3-0)3
TE	403	Textile Evaluation	(2-2)3
TE	405	Textile Finishing	(2-3)3
AS	401	(Air Science) or Elective approved by Division Head†	3 or 4
		Total credit hours	21 or 22

Second Semester

GS	302	Modern Labor Problems	(3-0)3
GS	412	Industrial Management	(3-0)3
GS	466	Management Problems	(3-0)3
GS	468	Business Finance	(2-0)2
TE	404	Textile Evaluation	(2-2)3
TE	406	Textile Finishing	(2-3)3
AS	402	(Air Science) or Elective approved by Division Head†	3 or 4
		Total credit hours	20 or 21

†The Textile Fashion Option is an approved elective; details concerning it will be found at the end of the preceding curriculum.

NOTE: For explanation of the Elective System, see page 62.

Subject Descriptions

All subjects offered at L.T.I. are listed alphabetically, regardless of the department involved, under the following headings:

AS	Air Science	LE	Leather
CH	Chemistry	MA	Mathematics
EL	Electronics	PA	Paper
EN	Engineering	PH	Physics
GS	General Studies	PL	Plastics
	TE	Textiles	

The number following the letter symbols is composed of three digits. The first digit of the number indicates the college year when the subject is normally presented, e.g., GS 111 is a freshman year subject; PA 414 is a senior year subject. Subjects numbered 500 and above are restricted to graduate students.

Except for basic mathematics, first-semester subjects are designated by odd numbers and second-semester subjects by even numbers. Hyphenated numbers indicate subjects continuing throughout the year.

Following the names of the individual subjects, the number of lecture-recitation and laboratory hours is indicated within the parentheses and the credit hour is shown outside. In the case of a year course the credit shown is the total for the year.

Examples of the above coding are as follows:

(2-6)4 means 2 hours of lecture-recitation and 6 hours of laboratory for 4 credits; (2-3) (1 6) 6 indicates 2 hours of lecture-recitation and 3 hours of laboratory for the first semester followed by 1 hour of lecture-recitation and 6 hours of laboratory the second semester, for a total credit of 6.

The prerequisites for the various subjects are shown in brackets, e.g., [EN 111]. No student can be officially registered in a subject until the indicated prerequisites have been satisfactorily completed.

The following descriptions are valid for entering freshmen (Class of 1960) and reflect many changes, particularly in credit hours. Upperclassmen are cautioned to refer to the Catalogue Issue of 1954-1955 for information applicable to their classes.

AIR SCIENCE

AS 101-102 — Air Science I — (2-1)(2-1)4

Introduces the AFROTC cadet to the history of aviation and its development into the jet air-age. Provides the student with a fundamental knowledge of principles of flight, aircraft engines, and global geography, and acquaints him with the international tensions and security structures of various nations of the world. Classes in leadership and drill provide for the development in the student of the qualities of leadership and discipline essential to Air Force officers.

AS 201-202 — Air Science II — (2-1)(2-1)4

Introduction to the elements and potentials of air power. The course considers air power in terms of targets, weapons, aircraft, bases and operations. Consideration is also given to the USAF Officer Career Program and the moral responsibility of Air Force leaders.

AS 301-302 — Air Science III — (4-1)(4-1)8

Concerns the development of certain specialized intellectual skills in the area of military law, command and staff, problem solving, communication and instruction in the Air Force, and certain technical skills in the area of weather, navigation and air base functions.

AS 401-402 — Air Science IV — (4-1)(4-1)8

Seminar in principles of personnel management. The framework of international politics; world powers and strategic areas; the security problem in relation to international power clashes. Principles of warfare and a historical survey of air warfare. Briefing for commissioned service and a leadership laboratory.

CHEMISTRY

CH 101 **General Inorganic Chemistry** **(4-3)4**

Chemical principles and calculations. The chemistry of the non-metallic elements and their compounds. This course is divided into two sections on the basis of previous training as indicated by a comprehensive examination upon entrance.

(3 hr. lect., 1 hr. recit., 3 hr. lab.)

CH 102 **General Inorganic Chemistry** **(4-3)4**
[CH 101]

A continuation of CH 101 to include the metallic elements and their compounds. This course is also divided into sections like CH 101.

(3 hr. lect., 1 hr. recit., 3 hr. lab.)

CH 201-202 **Organic Chemistry** **(3-3)(3-3)8**
[CH 102]

The classification, structure, mechanism of reaction, and behavior in bulk of certain organic molecular species. Emphasis is given to the properties of organic substances of possible importance in industries based upon the use of organic polymers, such as the textile, paper, leather and plastics industries. The laboratory work attempts to illustrate properties of some of the classes of organic substances together with some of the techniques employed in organic laboratory operations.

CH 203 **Elementary Organic Chemistry** **(3-0)3**
[CH 102]

This subject enables students not majoring in chemistry to become conversant with the names, structural formulas, properties and uses of some important industrially-available organic substances and with the role which organic chemistry plays in industry and engineering.

CH 205 and 206 **Qualitative Analysis** **(2-6)4**
[CH 102]

Mass action principles and systematic analysis of inorganic compounds by semi-microtechnique.

CH 211 and 212 **Quantitative Analysis** (3-8)6
[CH 102]

The fundamental principles of quantitative analysis. The principles and calculations of gravimetric analysis, including separations involved in mineral samples as well as the analysis of soluble salts; the principles and calculations of volumetric analysis, including neutralization methods, permanganimetry, dichromate and cerate oxidimetry, and iodimetry; and an introduction to the principles of colorimetry, compleximetry, and electrodeposition.

CH 252 **Chemistry and Physics of Fibers** (2-3)3
[CH 201 and 211]

Study of structure and chemical reactions of linear high polymers of importance in the field of natural and synthetic fibers; chemical and physical structure of polymers and fibers; relation of molecular length, orientation, crystallinity, inter-molecular attractions, side chains, and flexibility of polymers to the physical properties of fibers; chemical reactions of polymers and their effects on fibers.

CH 290 **Introduction to Chemical Engineering** (3-3)4
[CH 211]

An introductory study of the principles of material and energy balance, equilibrium, and rate of reaction. Examples are studied in the laboratory. The student is encouraged to develop his initiative and resourcefulness in obtaining experimental data, analyzing results, and communicating his findings by written and oral reports.

CH 302 **Introduction to Textile Chemistry** (1-3)2
[CH 102]

Lectures for the non-chemist on the various processes preliminary to dyeing. The preliminary treatments given the natural and manufactured fibers are studied as well as the action and properties of the textile chemicals used in these processes.

CH 311 **Textile Quantitative Analysis** (1-3)2
[CH 212]

The examination and evaluation of chemicals utilized in the textile mill, the dyehouse, and the finishing plant. Emphasis is placed on the practical techniques employed in the standard methods for bleaching agents, industrial water, soaps, oils, and synthetic detergents. Examples of fractional precipitation, complex methods and colorimetry are included.

CH 312 — Textile Quantitative Analysis — (1-3)2
[CH 311]

A continuation of CH 311 with emphasis on advanced analytical methods and an introduction to instrumental analysis. This option offers an opportunity for group and individual projects and includes report writing.

CH 331-332 — Physical Chemistry — (3-1½)(3-3)8
[CH 211 or 212, MA 202, PH 202]

The important principles of physical chemistry, i.e., gaseous, liquid, solid states; elementary chemical thermodynamics; determination of molecular weights; viscosity; surface tension, etc. Topics covered include dilute solutions, chemical equilibrium, phase equilibrium, free energy, and electrical properties of solutions.

CH 333 — Industrial Stoichiometry — (3-0)3
[CH 211 or 212, PH 201]

A study of some important operations in the chemical industry, e.g., sulfuric acid, and in the pulp and paper industry from the standpoint of the application of reaction rate, mass and energy balance to prediction of performance, yield, etc. Recirculatory processes are also studied.

CH 334 — General Colloid Chemistry — (3-0)3
[CH 331]

The approach is from the standpoint of the theoretical properties of the colloid system. Interfacial phenomena, particle kinetics, electrical properties, viscosity characteristics are studied. The preparation of colloid solutions, the character of lyophobic and lyophilic sols, gels and emulsions are developed from the above fundamental properties.

CH 342 — Organic Qualitative Analysis — (1-3)2
[CH 202, and 205 or 206]

The standard non-physical methods of identification of unknown samples of organic substances which have been previously reported in the chemical literature.

CH 352 — Chemical Engineering — (3-0)3
[CH 102, CH 331, MA 202, PH 202]

Descriptive and quantitative information on unit conversion, dimensional analysis, materials of construction, flow of fluids, flow of heat, hygrometry, humidification, dehumidification, and drying

CH 353 — Chemistry of Fiber Purification — (2-3)3

[CH 202]

A study of the impurities present in textile fibers and fabrics and their removal. Both natural and manufactured fibers are taken up. This subject is covered by lecture, laboratory and pilot plant work.

CH 354 — Organic Chemistry of Colored Substances — (2-0)2

[CH 202]

The relation between the structure of an organic molecule or ion and its absorption in the ultraviolet or visible spectral region. The synthesis and reactions of selected colored organic substances.

CH 364 — Textile Colloid Chemistry — (4-0)4

[CH 331]

Basic principles of surface and colloidal chemistry and their applications in industry. Special emphasis is placed on applications to the textile field: wetting, detergency, and finishing processes, as well as the colloidal behavior of the fibers themselves.

CH 375-376 — Chemistry of High Polymers — (2-3)(2-3)6

[CH 202]

Definition and classification of high polymers; chemistry of the more important polymers including preparation, physical properties and chemical properties; mechanism and procedures for polymerization, copolymerization and condensation; physico-chemical investigations including molecular weight determination and distribution; the structure of high polymers including relationship of structure to properties; inter- and intra-molecular forces; states of aggregation; transition points; elasticity; viscoelastic behavior; cross linking; plasticization (internal and external); solvent action.

CH 401 — Introduction to Textile Chemistry — (1-3)2

[CH 302]

A continuation of CH 302. The application of various classes of dyes to natural and manufactured fibers. Methods of dyeing, fastness properties of different classes of dyes, the nature and use of dyeing assistants are stressed.

CH 408 and/or 409 — Advanced Studies in Chemistry — Credits to be arranged

[Permission of the Chairman of the Chemistry Division and the Instructor]

A course providing the student with the opportunity for advanced study in one of the fields of chemistry. Literature survey,

laboratory work, and reports as assigned in conferences with an instructor in analytical chemistry, organic chemistry, physical chemistry, inorganic chemistry, or textile chemistry. Offered by the staff of the Chemistry Division.

CH 422 Advanced Chemical Textile Testing (2-3)3
[CH 211 or 212, and 364]

Chemical methods of textile testing. Quantitative as well as qualitative determination of fiber content, finishing agents and dyestuffs on the fiber, fiber damage, etc. Optical methods of analysis and evaluation.

CH 441 Chemical Engineering (3-0)3
[CH 352]

A continuation of CH 352. The unit operations of evaporation, gas absorption, filtration and washing.

CH 442 Chemical Engineering Thermodynamics (3-0)3
[CH 332]

A study of the first law of thermodynamics. Heat capacity, perfect gases, phase rule and generalized pressure, volume and temperature relations. An introduction to the second law.

CH 451-452 Organic Chemistry of Polymeric Materials (3-0)(3-0)6
[CH 202, 321, 332]

The classification, mechanism of formation, structure, and properties of polymeric and amorphous materials arising from organic monomers and natural sources.

CH 453 Theory of Dyeing (2-6)4
[CH 353, 354, 422]

Study of the mechanism of chemical reactions of the important classes of dyes with natural and synthetic fibers; theory of reactions, mechanisms of chemical additives, physical and chemical variations of fibers, time, temperature, and agitation.

CH 454 Industrial Dyeing (2-8)4

The various classes of coal-tar dyes are applied to natural and manufactured fibers. The fastness properties and end use of fibers dyed with different classes of dyes are taken up. Work is also done in color matching, union dyeing, money value of dyes and pilot plant dyeing.

CH 456 **Printing** **(0-3)-1**

The principles of textile printing are demonstrated by means of a laboratory printing machine. The various thickeners are studied. The different classes of dyes are printed and their fastness properties are taken up.

CH 461 or 462 **Microbiology** **(1-3)2**

[CH 202]

This subject considers the fundamentals of mycological and bacteriological theory briefly but in suffcient detail so that the problem of the microbiological deterioration of textiles, paper, and leather may be discussed.

Methods of detecting mildewing, methods of testing textiles for mildew resistance and bacteriological water analysis are also studied.

CH 464 **Advanced Microbiology** **(1-3)2**

[CH 461 or 462]

Work is arranged according to the interests of the individual student. Laboratory exercises such as the identification of pure cultures, the comparison of commercial mildewproofing agents, etc. are typical.

CH 473-474 **Advanced Inorganic Chemistry** **(2-0)(2-0)4**

[CH 202 or 204]

This subject includes a discussion of past and modern theories of atomic structure including the application of wave mechanics to an understanding of the chemical bond. Additional topics include periodic classification of the elements, types of chemical bonds, structure of complexes and theories of acids and bases. The second semester is devoted to descriptive chemistry of the elements hydrogen, oxygen, nitrogen, carbon and boron families; the alkali and coinage metals; alkaline earth metals; zinc family and the transitional elements. Where possible, illustrations will be given of applications of inorganic materials to the textile, leather, paper and plastics industries.

CH 481 or 482 **Tracer Techniques** **(1-3)2**

[Permission of Instructor]

The use of radioactive substances as tracers. In the laboratory the fundamental techniques of counting, Feather analysis, "hot lab." syntheses, radioautographs, etc., are covered. The safe handling of radioactive materials at the microcurie level will be stressed.

CH 491 Textile Chemistry Literature Seminar (2-0)2
[Permission of Instructor]

A study and discussion of current textile chemistry literature, stressing the critical analysis of the subject matter.

CH 501 Color Measurement for Textile Chemists (1-3)2
[CH 421 or equivalent]

The operation and use of transmission and reflection colorimeters, spectrophotometers, and recording spectrophotometers is studied by means of lectures and laboratory experiments. The calculation of results and the use of the instruments in dye application research are also investigated.

CH 503 Interpretation of Data (2-0)2

Mathematical methods of analyzing, plotting and interpreting experimental data, which lead to properly weighted quantitative results, are studied by means of lectures and exercises.

CH 505 Physical Chemistry of Dyeing (2-3)3

A combination of lectures, seminars, and laboratory experiments on the physico-chemical principles involved in the application of dyestuffs to textile materials.

CH 511 or 512 The Physical Chemistry of Surface-Active Agents (1-3)2
[CH 364]

A series of lectures and laboratory experiments on the physico-chemical principles involved in the use of surface-active agents in textile processing. The surface and bulk properties of the agents are studied and related to the over-all technical properties and uses.

CH 516 Chemical Thermodynamics (2-0)2

Lectures on the principles of thermodynamics and their applications to chemical and physical problems.

CH 521 or 522 Textile Testing Problems (1-3)2
[CH 421]

Special problems relating to the design and evaluation of improved analytical or testing procedures.

CH 525 or 526 **Evaluation of Finishing Agents [TE 312]** **Credits and hours to be arranged**

A laboratory study designed to teach the use of the various test methods and instruments in evaluating the effect of finishing treatments on the tactile and end-use properties of a fabric.

CH 527 **Instrumental Methods in Textile Research** **(1-2)2**

The use of instruments in textile chemical research. The lectures cover the general principles of instrumentation in the various fields considered. The laboratory exercises invoke the use of specific instruments and are designed to teach the student to make a proper choice of instrumental methods in common textile chemical problems.

CH 531-532 **Textile Chemistry Seminar** **(2-0)(2-0)4**

A series of informal discussions of current problems in research and technology in the textile chemistry field. Special investigations of the literature will be utilized to serve as a source of seminar topics.

CH 541-542 **Graduate Thesis** **Credits to be arranged**

The graduate thesis is to be an independent investigation of a problem by the student in conference with a faculty advisor and approved by the Department Head. A clear and systematic written presentation of the results is a required part of this subject.

ELECTRONICS

EL 102 **College Mathematics** **(5-0)5**

[Permission of Department Head]

Same as MA 104 with the addition of case study.

EL 104 **Physics** **(5-0)5**

[Permission of Department Head]

Same as PH 104 with the addition of case study.

EL 201-202 **Introductory Circuit Theory** **(3-0)(3-0)6**

[PH 104 and MA 104; EL 205-206 and EL 207-208 taken concurrently]

An introduction to the study of the mathematical and physical aspects of electric circuits in which radiation in the form of electromagnetic waves does not play a major role. Resistive circuits, Kirchhoff's laws, Thevenin's theorem, reciprocity of simple circuits, sinusoidal steady-state behavior, vector diagrams, resonance, transients in alternating current circuits, loci of complex functions, polyphase systems, and an introductory discussion of simple nonlinear circuits.

Text: Guillemin, *Introductory Circuit Theory.*

EL 203-204 **Elementary Electricity and Magnetism Laboratory** **(0-3)(0-3)2**

[PH 104; EL 201-202 taken concurrently]

The purpose of this subject is to give the student a working knowledge of the use of common electrical devices and measuring equipment as well as practice in the preparation of circuit drawings, the writing of technical reports and the analysis of the precision of measurements. Some attention will be given to the practical techniques useful in the construction of electrical equipment and accessories. Among the topics considered in the laboratory are: measurements of resistance, capacitance, inductance and impedance; DC and AC bridge circuits; magnetic measurements; characteristics of vacuum tubes and other non-linear devices; elementary vacuum tube circuits; AC and DC motors, and transformers.

Texts: Stout, *Basic Electrical Measurements;* Dunn and Barker, *Electrical Measurements Manual.*

EL 205-206 **Intermediate Engineering Physics** **(3-0)(3-0)6**

[PH 104 and MA 104; EL 207-208 taken concurrently]

The fundamental laws of electricity and magnetism presented from the point of view of field theory. Free use is made of the calculus. Topics in the first semester include: electrostatics, steady currents and their magnetic fields, induced electromotive forces and inductance, elementary alternating current circuits, and time-dependent magnetic fields. In the second semester the following topics are studied: electromagnetic waves in free space, on wires, and in material bodies; behavior of electrons in metals, thermionic emission, dielectric and magnetic properties of matter, geometrical optics, physical optics, atomic structures and topics in modern physics.

Text: Frank, *Introduction to Electricity and Optics,* 2nd Edition.

EL 207 **Intermediate Engineering Mathematics** **(4-0)4**

[MA 104]

A continuation of MA 104. Methods of integration, elementary vector analysis, elements of solid analytic geometry, partial differentiation, multiple integrals, infinite series, and the elements of complex variable theory. Stress is given to the application of the mathematics to problems in applied science and engineering.

Text: Thomas, *Calculus and Analytic Geometry.*

EL 208 **Differential Equations for Engineers** **(3-0)3**

[EL 207]

A general survey of ordinary differential equations and an introduction to partial differential equations and the Laplace transformation. Numerous applications are made to problems in physics, chemistry and geometry.

Texts: Reddick and Kibbey, *Differential Equations* (3rd Edition); Jaeger, *Laplace Transformation;* Peirce, *A Short Table of Integrals.*

EL 301-302 **Introduction to Physical Electronics** **(3-0)(3-0)6**

[EL 202 and EL 208]

The motion of charged particles in electric and magnetic fields, electronic phenomena in metals, statistical electron theory of metals, characteristics of thermionic cathodes, kinetic theory of gases, fundamental processes in gases, electrical discharges in gases, rectifiers and filters, photoelectricity, diodes, gas tubes, photoelectric cells, triodes and multielectrode tubes.

Texts: Millman and Seely, *Electronics;* Sproull, *Modern Physics.*

EL 303-304 **Electronic Circuits** **(3-0)(3-0)6**
[EL 202 and 208; EL 301-302 taken concurrently]

Characteristics of electronic tubes; graphical solutions for circuits containing non-linear elements; linear equivalent circuits; combinations of resistive, capacitive and inductive elements; response of basic circuits to simple wave forms; amplifiers; oscillators; clamping, clipping, and trigger circuits; voltage regulating circuits; multivibrators and counting circuits.

Texts: Corcoran and Price, *Electronics;* Martin, *Electronic Circuits.*

EL 305-306 **Electronics Laboratory** **(0-4)(0-4)4**
[EL 202, EL 204 and 206; EL 303-304 taken concurrently]

The purpose of this subject is to give the student a good working knowledge of a number of electronic circuits and the techniques of measurement for evaluating their performance. A number of these circuits are assembled by the student. Further training is provided in the analysis and reporting of experimental work. Development of the student's initiative, resourcefulness and independent judgment is encouraged.

Text: Reed, Wagner and Corcoran, *Electrical Communications Experiments.*

EL 307-308 **Electromagnetic Devices and Machinery** **(3-0)(3-0)6**
[EL 202, 206, and 208; EL 311-312 taken concurrently]

Dimensional analysis, free and forced response of dynamic systems, electromechanical analogies; electromagnetic, piezoelectric, magnetostrictive, electrothermal and electromechanical devices; indicating and recording equipment, electrical computers, and fractional horsepower motors.

Texts: Thaler, *Elements of Servomechanism Theory;* Kraus, *Electromagnetics;* Fitzgerald and Kingsley, *Electric Machinery.*

EL 309-310 **Instrumentation and Electromagnetics Laboratory** **(0-4)(0-4)4**
[EL 202, 204, and 206; EL 303-304 taken concurrently]

The purpose of this course is to familiarize the student with the construction and operation of various electromechanical devices and motors encountered in practice. Some attention is given to the study of the dynamic performance of these devices. The preparation of carefully written technical reports is encouraged.

Text: Fitzgerald and Kingsley, *Electric Machinery.*

EL 311-312 **Advanced Calculus for Engineers** **(3-0)(3-0)6**
[EL 208]

Ordinary differential equations, Laplace transformation, numerical methods of solving differential equations, series solutions of differential equations, boundary value problems and orthogonal functions, vector analysis, partial differential equations, partial differential equations of mathematical physics, and complex variable theory.

Text: Hildebrand, *Advanced Calculus for Engineers.*

EL 401-402 **Industrial Electronics and Servomechanisms** **(3-0)(3-0)6**
[EL 304 and 312]

A survey of industrial electronic control systems. Among the topics considered are: selsyns, amplidynes, regulators, servomechanisms, magnetic amplifiers, saturable reactors, inverters, high-current rectifiers, and high-voltage machines.

Texts: Brown and Campbell, *Principles of Servomechanisms;* Thaler, *Elements of Servomechanism Theory.*

EL 403-404 **Communication and Microwave Electronics** **(3-0)(3-0)6**
[EL 304 and 312]

Practice in the analysis of electronic systems. Beginning with zero frequency circuits, a study is made of the modifications required to give proper behavior as the frequency is increased. Among the topics considered are: radio frequency circuits, television circuits; amplitude, frequency, and pulse modulation; elements of electromagnetic theory, antennas, waveguides, microwave generators and receivers.

Texts: Reich, *et al, Microwave Theory and Techniques;* Reintjes and Coate, *Principles of Radar;* Panofsky and Phillips, *Classical Electricity and Magnetism.*

EL 405-406 **Introduction to Solid State Electronics** **(3-0)(3-0)6**

A broad survey of solid state electronics. Elements of crystal physics; elastic thermal and electrical properties of crystals; piezoelectricity; elements of the wave theory of matter; energy levels in solids; band theory of solids; Brillouin zones; Fermi-Dirac statistics; electron theory of metals; thermal and ionic diffusion; thermionic emission; field emission; electrical contacts; semi conductors; rectification; transistor physics; insulators; radiation and atomic structure, photoelectricity and photoconductivity, secondary emission; magnetic, paramagnetic, and diamagnetic properties of solids; ferro-

and ferri-magnetism; ferroelectricity; surface phenomena; adsorption, and catalysis.

Texts: Mandl, *Quantum Mechanics;* Kittel, *Solid State Physics;* Shockley, *Electrons and Holes in Semiconductors.*

EL 407-408 Experimental Electronic Techniques (1-0)(1-0)2

Vacuum tube construction, vacuum technology, the metallurgical and mechanical properties of some metals, glass working, glass-to-metal seals, welding and soldering, phosphor and semiconductor technology, high-temperature properties of materials, behavior of materials at high frequencies, miniaturization of components, reliability of components, and the fabrication of electronic components.

Text: Braddick, *Physics of Experimental Method.*

EL 409-410 Electronic Projects Laboratory (0-4)(0-4)4
[EL 306 and 310]

In this subject the student is given the opportunity to develop, construct, study, modify, and test electronic components and systems. He is expected to carry out his investigations more or less independently. Original investigations are encouraged but not required. The careful preparation of technical reports on the experimental work is emphasized. Where practicable, the student is expected to write his reports using the style of either the *Journal of the Institute of Radio Engineers* or the *Review of Scientific Instruments.*

Texts: Wilson, *An Introduction to Scientific Research;* Reich, *et al, Microwave Theory and Techniques.*

EL 411-412 Applied Electronics Laboratory (0-4)(0-4)4
[EL 306 and 310]

The purpose of this subject is to give the student an experimental familiarity with the nature, application and performance of various electronic devices. Emphasis is given to the preparation of good technical reports.

Text: Terman and Petit, *Electronic Measurements.*

EL 421-422 Advanced Engineering Physics (3-0)(3-0)6
[EL 302 or permission of instructor]

The aim of this subject is to present a unified view of the various fields of classical and modern physics and to show their relation to engineering.

Text: Evans, *The Atomic Nucleus.*

EL 501-502 **Seminar in Electronics** **(1-0)(1-0)2**
Not offered in 1956-1957

Discussion by staff members and students of current journal publications and topics of current interest in electronic science, electronic engineering and related areas of applied physics.

EL 503-504 **Intermediate Solid State Electronics** **(3-0)(3-0)6**
[EL 406]
Not offered in 1956-1957

An intensive study of selected topics in solid state electronics.
Texts: Shockley, *Electrons and Holes in Semiconductors;* Slater, *Quantum Theory of Matter;* Peierls, *Quantum Theory of Solids.*

EL 505-506 **Electronic Control and Measurement** **(3-0)(3-0)6**
[EL 304 or equivalent]
Not offered in 1956-1957

The basic principles of electronic devices used for control and measurement in applied science and engineering.
Text: Truxal, *Automatic Feedback Control System Synthesis.*

EL 507-508 **Transients in Electromechanical Systems** **(3-0)(3-0)6**
[EL 302 or equivalent]
Not offered in 1956-1957

Training in the formulation and solution of ordinary and partial differential equations which arise in the treatment of mechanical, acoustical, thermal and electrical systems. Extensive use is made of modern operational mathematical techniques.
Text: Gardner and Barnes, *Transients in Linear Systems.*

EL 509-510 **Microwave Electronics** **(3-0)(3-0)6**
[EL 404]
Not offered in 1956-1957

Elements of electromagnetic theory, transmission lines, impedance matching, waveguides, antennas, microwave oscillators and amplifiers, klystrons, magnetrons, and travelling wave tubes.
Texts: Reich, *et al, Microwave Theory and Techniques;* Reintjes and Coate, *Principles of Radar;* Panofsky and Phillips, *Classical Electricity and Magnetism.*

EL 511-512 **Electromagnetic Theory** **(3-0)(3-0)6**
[EL 422]
Not offered in 1956-1957

Maxwell's equations, stress and energy, the electrostatic field, the magnetostatic field, plane waves in isotropic media, cylindrical waves, spherical waves, radiation, and boundary value problems.
Text: Stratton, *Electromagnetic Theory.*

EL 513-514 **Special Problems in Electronics** **Credits and hours to be arranged**

Not offered in 1956-1957

The purpose of this subject is to give the student an opportunity for individual study, under the direction of a staff member, of topics in or related to electronic engineering.

EL 515-516 **Graduate Research** **Credits and hours to be arranged**

Not offered in 1956-1957

Supervised research on some problem in electronic science, electronic engineering, or in certain areas of applied physics. The results of the research are to be embodied in a thesis acceptable to the departmental committee on graduate study.

EL 521 **Vector and Tensor Analysis** **(3-0)3**

Not offered in 1956-1957

The algebra of vectors, differential vector calculus, differential geometry, integration, tensor analysis and Riemannian geometry. Frequent applications are made to problems in mechanics, hydrodynamics, elasticity, and electricity.

Text: Lass, *Vector and Tensor Analysis.*

EL 522 **Matrix and Tensor Analysis** **(3-0)3**

Not offered in 1956-1957

Matrix and tensor analysis and their applications to problems in engineering and physics.

Text: Sokolnikoff, *Tensor Analysis—Theory and Applications.*

EL 523 **Complex Variables** **(3-0)3**

[EL 206]

Not offered in 1956-1957

Complex numbers, series expansions of analytic functions, residues and poles, contour integration, conformal mapping, Schwarz-Christoffel transformations, analytic continuation, Riemann surfaces, and multi-valued functions. Emphasis is given to topics considered most essential to physics and engineering.

Text: Churchill, *Introduction to Complex Variables.*

EL 524 **Fourier Series and Boundary Value Problems** **(3-0)3**

Not offered in 1956-1957

The theory of Fourier series and its application to the solution of boundary value problems. Bessel functions, Legendre polynomials, and Fourier integrals.

Text: Churchill, *Fourier Series and Boundary Value Problems.*

EL 525-526 Modern Operational Mathematics (3-0)(3-0)6

Not offered in 1956-1957

Applications of the Laplace transform technique to the solution of ordinary and partial differential equations with special reference to those which arise in the analysis of electrical circuits, mechanical vibrations, heat conduction, and automatic control.

Texts: Churchill, *Modern Operational Mathematics;* McLachlan, *Complex Variable Theory and Operational Calculus.*

EL 527-528 Methods of Applied Mathematics (3-0)(3-0)6

[EL 302]

Not offered in 1956-1957

The aim of this subject is to give the student a working knowledge of a number of facts and techniques relevant to the following topics: matrices, determinants, linear equations, linear vector spaces, characteristic-value problems; calculus of variations, Hamilton's principle and Lagrange's equations; difference equations; integral equations, Green's function, analytical and numerical methods for obtaining solutions of integral equations.

Text: Hildebrand, *Methods of Applied Mathematics.*

EL 529-530 Solid State and Modern Physics For Engineers (3-0)(3-0)6

Not offered in 1956-1957

Elements of electronics, special theory of relativity, atomic structure of matter, quantum mechanics, x-rays, molecular structure and molecular spectra, low-temperature phenomena, natural and induced radioactivity, nuclear fission, cosmic rays and mesons, elements of crystal physics, specific heats, alloys of metals, elastic and plastic properties of solids, rupture and fatigue of solids, thermal diffusion, electron theory of metals and alloys, thermal and electrical properties of solids, energy levels in solids, cohesion in solids; magnetic, paramagnetic and diamagnetic properties of solids; magnetic moments and resonance, transistor physics, semiconductors and electron diffusion in metals.

Texts: Kittel, *Solid State Physics;* Slater, *Quantum Theory of Matter;* Peierls, *Quantum Theory of Solids.*

EL 533-534 Elementary Quantum Mechanics (3-0)(3-0)6

Not offered in 1956-1957

The postulational formulation of quantum mechanics. The basic theory is developed both in the operator and matrix formulations.

Texts: Schiff, *Quantum Mechanics;* Persico, *Fundamentals of Quantum Mechanics.*

EL 535 Thermodynamics and Kinetic Theory (3-0)3

Not offered in 1956-1957

The first, second, and third laws of thermodynamics, thermodynamic functions, chemical thermodynamics, thermodynamics of multicomponent systems, equations of state; elementary kinetic theory, mean free path, thermal conductivity, viscosity, and transport phenomena.

Text: Allis and Herlin, *Thermodynamics and Statistical Mechanics.*

EL 536 Kinetic Theory and Statistical Mechanics (3-0)3

Not offered in 1956-1957

A continuation of EL 535. In addition to some topics in the kinetic theory of liquids and solids, the following are considered: entropy and probability, Maxwell-Boltzmann statistics, equipartition of energy, quantum statistics, and degenerate gases.

Text: Tolman, *Principles of Statistical Mechanics.*

ENGINEERING

EN 111 **Engineering Graphics** (0-6)2

Freehand and mechanical drawing, including lettering, geometric construction, orthographic projection, isometric and cabinet drawing, and dimensions.

EN 112 **Engineering Graphics** (0-6)2
[EN 111]

A continuation of EN 111 which includes the following topics: auxiliary views, cross sections, advanced dimensioning, sketching of machine parts, working drawings, tracing and blueprinting, intersections, and developments.

EN 122 **Machine Tool Laboratory** (1-2)1

The objective of this subject is to give the student an insight into the processing of metals through lectures and practical laboratory applications covering the basic machine tools such as the lathe, shaper, drill-press, and milling machine, and also the uses of measuring instruments, threads, and gears. Lectures and demonstrations cover topics such as pattern work, foundry practice, die-casting, welding, and forging.

EN 201 **Machine Drawing** (0-3)1
[EN 112]

Several short problems involving centers of gravity, counterweights, cam layouts, piping, welding, sheetmetal drafting, and assembly drawings.

EN 203 **Mechanism** (3-0)3

The basic principles of kinematics, in which the wide variety of process machinery available furnishes many specific examples. Frequent use of these mechanisms is made in the development of the subject. Some of the important topics covered are the following: rolling cylinders and cones, gearing, gear train design, epicyclic gear trains, flexible connectors including stepped pulley and cone design, cam design, linkages, and miscellaneous mechanisms.

EN 205 **Mechanism** (3-2)4
[PH 101 or 103]

Similar to EN 203, except that laboratory time has been provided to allow study of textile mechanisms.

EN 207 **Machine Drawing** **(0-6)2**
[EN 112]

Problems involving centers of gravity, counterweights, cam layouts, piping, welding, sheetmetal drafting, and assembly drawings.

EN 220 **Textile Mechanism** **(1-2)2**
[EN 203]

The graphical and mathematical analyses of advanced mechanism found in textile machinery. The forces in, and velocities of, the various members of the mechanism are determined from actual data taken from the machines by the student himself.

EN 222 or 223 **Applied Mechanics** **(3-0)3**
[MA 201, taken concurrently if necessary, and PH 101]

The fundamentals of statics and kinetics, including such topics as force systems, laws of equilibrium, centers of gravity, moments of inertia, analysis of stresses in framed structures, momentum, energy, work and power, and the dynamics of the translation and rotation of rigid bodies.

EN 232 **Engineering Materials** **(3-2)4**
[PH 202]

The manufacture, properties, and uses of important ferrous and non-ferrous metals; hot and cold processing, alloying, heat treatment; also the properties and use of non-metallic engineering materials such as timber, cement, concrete, rubber, plastic, and mechanical fabrics.

EN 233 **Machine Tool Laboratory** **(0-3)1**

A continuation of EN 122, giving practical and more detailed instruction in such operations as lay-outs, filing, drilling, planing and shaping, and placing special emphasis on precision work.

EN 301-302 **Advanced Applied Mechanics** **(3-0)(3-0)6**
[EN 222, MA 202]

Strength of materials, including such topics as simple stresses, strain, bending moments, shearing force, slopes and deflections in beams, beam design, torsion, and design of shafts.

The work of the second semester deals with continuous beams, compound beams and columns, eccentric loading, combined stresses, reversals of stress, impact stresses, vibrations, and stress analysis by strain gage methods.

EN 303 — Electrical Circuits — (3-2)4

[PH 202]

Not offered in 1956-1957

Ohm's law and Kirchhoff's laws, direct current networks, Thevenin's theorem, impedance, representation of alternating quantities by vectors, sinusoidal steady-state properties, power, series and parallel resonance, polyphase systems, network theorems for steady-state alternating current circuits, coupling networks, transients in simple circuits, Fourier series.

EN 304 — Textile and Electronic Instrumentation — (2-2)3

[PH 102 or 104, and 201]

A study of indicating and recording instruments used to measure such common textile process variables as pressure, temperature, humidity, liquid level, fluid flow, etc. An introduction also to electronic circuitry as it relates to textile processing instrumentation controls.

EN 305 — Thermodynamics — (3-0)3

[MA 202, PH 201]

Not offered in 1956-1957

Properties of gases and vapors, reversible and irreversible cycles, mixtures of gases, combustion, and products of combustion.

EN 307 — Surveying and Structures — (3-3)4

[EN 301 taken concurrently]

Not offered in 1956-1957

The fundamental principles of plane surveying, topographic surveying and mapping, principles of structural engineering, algebraic and graphical analysis of forces, calculation of allowable floor loads, stresses in beam and allowable loads on columns.

EN 308 — Structures — (3-0)3

[EN 307]

Not offered in 1956-1957

Rigid frames analysis, wind stresses, stresses in riveted trusses, reinforced concrete structures, footings, foundations.

EN 311 — Heat and Power — (2-2)3

[PH 201]

Similar to EN 403 but briefer and designed for those not majoring in engineering.

EN 321 — Strength of Materials — (3-0)3

[MA 201, PH 101 or 103]

A more elementary and condensed treatment of EN 301-302.

EN 325 or 326 **Applied Mechanics** (3-0)3
[MA 201, taken concurrently if necessary, and PH 101 or 103]

The fundamentals of statics, including such topics as force systems, laws of equilibrium, friction, centers of gravity, moments of inertia, stress fundamentals, strain, bending moment and deflection.

EN 327 **Strength of Materials** (3-0)3
[EN 325]

A condensed treatment of EN 301-302, this subject covers such topics as beams, beam design, torsion, columns, combined stresses, reversals of stress and impact.

EN 328 **Strength of Materials** (3-0)3
[EN 325]

Principles of the strength of materials with special emphasis on their applications to plastics. Includes such topics as bending and shearing stresses, torsion, compound beams and columns, reversals of stress, impact, vibrations, stress analysis by strain gage methods, concepts of creep and relaxation.

EN 331 **Mill Engineering** (3-0)3
[EN 222]

The various types of building construction in the textile industry, including details of construction from a study of actual blueprints, calculation of allowable floor loads, stresses in beams and columns, machinery layout and the use of the transit in elementary surveying.

EN 332 **Engineering Materials** (2-0)2
[PH 201]

The manufacture, properties, and uses of important ferrous and non-ferrous metals; hot and cold processing, alloying, heat treatment; also the properties and use of non-metallic engineering materials such as timber, cement, concrete, rubber, plastic, and mechanical fabrics.

EN 342 **Principles of Electrical Engineering** (3-2)4
[PH 321]

The greater part of the subject is devoted to direct-current generators and motors with a study of their construction and characteristics. Three-phase circuits and alternators are also considered. The accompanying laboratory work illustrates the various methods of measuring polyphase power and of determining the characteristics of direct-current generators and motors.

EN 344 **Electrical Machinery** **(3-2)4**

[PH 321]

A condensation of EN 342 and EN 401.

EN 351 or 352 **Statistical Methods** **(3-0)3**

[MA 201]

The fundamental statistical measures and methods required for the analysis of experimental data; also the practical applications of statistical analysis to quality control and to the planning of industrial experiments.

EN 401 **Principles of Electrical Engineering** **(2-2)3**

[EN 342]

Alternator regulation, parallel operation, single-phase and three-phase transformers, induction motors and their applications to the textile industry, starting devices for motors, synchronous motors, and correction of power factor.

EN 402 **Electrical Control Systems** **(3-2)4**

[EN 401]

Not offered in 1956-1957

The operation of simple servomechanisms, potentiometers, synchros and related error detectors, double speed synchronizing networks, demodulators and modulators, electronic amplifiers, servomotors, magnetic and rotating amplifiers, design of servomechanisms, tests of servomechanisms.

EN 403 **Principles of Heat Engineering** **(3-2)4**

[EN 203, MA 202, PH 201]

The basic principles of thermodynamics, properties of steam and its utilization in manufacturing processes, and the combustion of fuels. A brief treatment of steam engines, turbines and pumps. Special consideration is given to the use of steam in manufacturing processes.

EN 404 **Heat Transfer** **(2-0)2**

[MA 202, PH 201]

Not offered in 1956-1957

Conduction, convection, and radiation. Steady and unsteady state of conduction. Heat transfer in tubes and from plane surfaces. Heat exchangers, fin tube radiators, emissivity, and absorptivity.

EN 405 **Electronic Controls and Power Circuits** **(3-2)4**

[PH 102 or 104]

Not offered in 1956-1957

Power requirements in single-phase and three-phase power circuits; operating characteristics of various types of direct-current

and alternating-current motors and their manual and automatic controls; industrial electronics including photoelectric relays, time delay relays, motor control, and side register control as applied in the plastics industry.

EN 406 — Fluid Mechanics — (3-2)4
[MA 202, PH 202]

Properties of fluids; statics of fluids; flotation; relative equilibrium; dynamics of fluids, Bernoulli's theorem, measurement of velocity and pressure; cavitation; flow of viscous fluids; Reynolds' number; flow in pipes; flow with free surface; critical depth; weirs; orifices and nozzles; impulse and momentum in fluids; resistance of immersed and floating bodies. Froude's number, boundary layer; dynamics of compressible fluids; Mach's number; dynamical similitude and Pi theorem.

EN 411 or 412 — Advanced Heat Engineering — (3-2)4
[EN 305]

The kinematics of stationary steam generating units, reciprocating engines, steam turbines, pumps, condensers, and internal combustion engines. Special attention is given to the use of steam for processing purposes in industry.

EN 420 — Industrial Instrumentation — (2-3)3
[PH 202]

Similar to EN 422 with the addition of three hours of laboratory per week.

EN 422 — Industrial Instrumentation — (2-0)2
[PH 202]

Modern methods of measurement and control of the more common process variables such as temperature, pressure, liquid level, and fluid flow; response characteristics of mechanical, electric and electronic instruments; modes of control; associated mechanical and electrical mechanisms; characteristics of final control elements; closed-loop control systems; process characteristics and their effects upon the selection of the correct mode of control.

EN 427-428 — Machine Design — (2-3)(2-3)6
[EN 302 or 321]
Not offered in 1956-1957

The design of machine elements, such as fasteners, shafts, frames, bearings, gears, clutches, springs, keys and drives. Data for most of the problems are taken from actual machines in the various laboratories.

EN 430 Engineering Design of Textile Structures (3-0)3
Not offered in 1956-1957

This subject correlates engineering properties of textile materials, engineering principles, and textile processing in the design of textile structure with desired properties. The geometry of yarns and fabrics; design of textile structures for certain functional uses; prediction of dimensional changes which occur during use; stresses, strains, and energy changes which the end-use imposes; analyses of load-elongation diagrams of textile structural material.

EN 431 or 432 Advanced Physical Textile Testing (2-3)3

Compression testing, engineering properties of fibers and yarns, stress-strain-time phenomena of visco-elastic materials, theory and operation of strain gage testing machines, methods of measurement of yarn evenness, thermal transmission, flexibility of fabrics, fabric friction, bursting stress, and crimp. Use of the microscope in determination of wool quality, filament area and number. Statistical analysis of data.

EN 433 Manufacturing Tools and Methods (3-0)3
Not offered in 1956-1957

Designed to familiarize students with manufacturing methods and machines in general industrial work. Plant layout and planning; machine tool performance; power transmission and control; product evaluation and quality control.

EN 502 Statistical Quality Control (3-0)3
[EN 351 or 352]

A study of the various types of control charts for maintaining quality of manufactured products and of the several types of sampling plans for the reduced inspection of manufactured products and of raw materials. Applications of the foregoing statistical techniques to industry in general are discussed, with special emphasis on their application to the textile and other industries.

EN 503 or 504 Air Conditioning (2-2)2
[PH 201]

The fundamental principles of heating, ventilating, and refrigeration. The laboratory consists of design problems in the air conditioning of industrial buildings.

EN 505 or 506 Methods of Experimental Stress Analysis (3-1)3
[MA 202, PH 202, EN 302]

An introduction to some of the experimental techniques used in stress analysis. Photoelasticity, electrical strain gages, brittle

coating, and mechanical gages are considered in relation to the analysis of both static and dynamic stresses. Special attention is given to the application of these techniques in the study of textile structures and machinery.

EN 507 or 508 — Fluid Mechanics — (3-0)3
[MA 202, PH 202]

Similar to EN 406 but without laboratory work.

EN 509 or 510 — Advanced Statistical Methods — (3-0)3
[EN 351 or 352]

A continuation of EN 351 or 352 with particular study of the more advanced statistical techniques as applied to the design of industrial experiments and to the analysis and interpretation of the resulting data.

EN 511-512 — Graduate Thesis — Credits to be arranged

Each graduate student in Textile Engineering is required to submit a thesis which shows ability and originality in the solution of a research project.

EN 513-514 — Graduate Seminar — (1-0)(1-0)2

Required of all graduate students in Textile Engineering.

GENERAL STUDIES

GS 101-102 World Economic Geography (2-0)(2-0)4

Through a study of this subject the student gains an appreciation of the economic status of the different geographic areas of the world. The effect of climate, the geographic structure, and the distribution of important raw materials upon the activities of the people inhabiting those areas and on the types of industry which support the economic life of the various regions.

GS 111 English Composition (3-0)3

Thorough training in the fundamental rules of correct expression, grammatical principles, sentence and paragraph construction, and vocabulary development. A written theme is assigned each week.

GS 112 English Composition and Readings (3-0)3
[GS 111]

A practical application of the principles studied in GS 111. The student is trained to express himself with clarity and accuracy and to think creatively when he is reading. Weekly assignments in an omnibus of essays and the writing of themes based on the outside readings or on other topics are required.

GS 122 Perspective Drawing (1-1)1

A mechanical method of representing objects of three dimensions showing correct proportions as they appear to the eye.

GS 132 Freehand Drawing (0-3)1

Freehand drawing of objects of different textures. Visual training and graphic expression to build a drawing vocabulary which will aid in advanced drawing subjects.

GS 201-202 Economics (3-0)(3-0)6

The principles and practices of economics and a brief study of economic history.

GS 205 or 206 Man and His Environment (3-0)3

The biological aspects of fundamental problems of heredity and environment which confront man in his economic, social, and cultural life. Emphasis is given particularly to the fields of ecology, genetics and eugenics, evolution, and anthropology.

GS 209 or 210 **Speech** (2-0)2
[GS 112]

The aim of this subject is to achieve effective delivery of various types of speech. All kinds of delivery are studied and analyzed.

GS 211 or 212 **Business English** (2-0)2
[GS 112]

Analysis and practice in letter writing and a study of the basic forms of technical exposition, forming a background for report writing in advanced courses and in industrial activity.

GS 222 **Appreciation of Literature** (3-0)3
[GS 112]

The principles of literary appreciation and criticism. An analysis of prose and poetical selections, with directed investigation of the various literary appeals—the intellectual, the sensory, the emotional, the aesthetic, the imaginative, and the philosophical.

GS 223 or 224 **The United States Since 1865** (3-0)3

A survey of the advancement of the American people from the Reconstruction Era through World War II.

GS 226 **World History Since 1900** (3-0)3

Particular attention is paid to the years 1919-1939 and such topics as the rise of new states; the origin and development of new concepts of nationalism, racism, and other phenomena; the alignment of world powers for World War II; and the role of the United States in mid-twentieth century reconstruction.

GS 232 **Comparative Literature** (3-0)3

A consideration of at least six classics of western civilization as keys to the development of literary types. An attempt to deduce standards of critical judgment. Class discussions and critical papers.

GS 261-262 **Technical German** (3-0)(3-0)6

The basic elements of German, leading to the development of reading ability in scientific German.

GS 301 **Economic Development of the United States** (3-0)3

A brief review of the background of the present economic system and an intensive study of the influence of science and technology upon our economic development. The central theme is the dominant role of the science and technology of our time in present-day American life.

GS 302 Modern Labor Problems (3-0)3

Case material is studied to familiarize the students with Federal and State court actions, rulings of the National Labor Relations Board, and the functions of both public and private conciliators and arbitrators. At intervals during the semester, the class meets informally with representatives of both Labor and Management. The chief objectives of this study are (1) a proper consideration of the important current issues in collective bargaining and (2) the development of familiarity with the techniques of the bargaining table and the problems in drafting, interpreting, and administering the modern labor contract.

GS 303 Psychology (3-0)3

The place of psychology in the life of the individual and society. Physiological bases of behavior and experience, attention, perception, memory, thinking, emotions, intelligence, and personality in terms of the whole person in his social setting.

GS 311 Economic Statistics (3-0)3

Basic concepts of the statistical method with special emphasis on those approaches of most interest to the student of management. Topics covered include: measures of central tendency, graphic methods, dispersion, skewness, sampling, normal curve, index numbers, correlation, time series, secular trend, seasonal variation, business cycle, and statistical forecasting.

GS 313 Money and Banking (3-0)3

Monetary and banking systems, particularly those in the United States. Monetary theory and standards, the Federal Reserve, individual bank management, fiscal and credit policies.

GS 314 Philosophy of Science (3-0)3

This subject analyzes the methods and techniques of inductive and deductive science. Elementary logic is studied and applied to the necessary structure of scientific systems. The great concepts and generalizations which have marked the history of science are reviewed and analyzed, as well as the interrelation of science and general philosophy.

GS 321-322 Marketing Principles and Practices (3-0)(3-0)6

GS 321 is an introduction to the basic principles of distributing goods with special emphasis on the textile industry. The selling agent, the commission man, the broker, jobber, merchant, factor, and other intermediaries.

GS 322 is a continuation of GS 321. Economic aspects of fashion, branding, sales promotion and advertising, market re-

search, analysis of distribution costs, forecasting, market potentials, price policies, legal aspects of marketing, vertical integration, sales planning and control and the complete campaign.

GS 341 Accounting - I (3-0)3

The economic significance of accounting, the underlying accounting theories, and the organization and use of modern accounting records. The preparation and interpretation of reports and statements of financial position. The balance sheet, profit and loss statement, theory of debits and credits as applied to journalizing, and the usage of the various ledgers. Cost accounting methods and systems as applied to industry.

GS 342 Accounting - II (3-0)3

A continuation of GS 341 with emphasis on partnership and corporate records. Payroll and tax accounting; installment and branch accounting techniques. The peculiar aspects of manufacturing accounting are covered in detail, with the application of cost principles to this area.

GS 343 Principles of Selling and Advertising (3-0)3

The fundamental principles of advertising and salesmanship. Psychology of selling and advertising, copy writing, layout, printing and engraving, testing and research, planning an advertising campaign, government restrictions, types of media, radio advertising, trademarks, building a selling talk, fundamentals of salesmanship, types of personal selling, personality, retail salesmanship, training, etc.

GS 351 or 352 Elements of Marketing (2-0)2

A condensation of the more important elements of marketing covered in GS 321-322, designed to give the student an understanding of marketing as it affects wholesaling, retailing, and the consumer. Market research, advertising, branding, and vertical integration.

GS 361-362 Advanced Technical German (3-0)(3-0)6
[GS 262 or equivalent]

GS 361 may be taken without continuing GS 362.

This subject is designed to expand the student's elementary understanding of the language, to increase vocabulary, and to develop reading aptitudes in special fields of interest selected by the student.

GS 401 or 402 Industrial Relations Seminar (2-0)2
[Permission of Instructor]

This subject gives a small, selected group opportunities to meet with the instructor and occasional visitors in discussion of current

problems in industrial relations. Case material and hypothetical problems in modern labor management provide the basis for group study.

GS 412 Industrial Management: Principles and Problems (3-0)3

Backgrounds of modern industry; organization of the industrial enterprise; the operation of modern industry; and coordination of the productive processes. Among the topics covered are: risks, forecasting, financing, product development, plant layout, production controls, personnel management, time and motion studies, job evaluation, and wage and salary administration. The text material is supplemented with current readings and case material.

GS 421 or 422 Foreign Trade (3-0)3
[GS 202]

The growth and development of foreign trade, international commercial policies, transportation and communication facilities, and international finance. The practical aspects of exporting and importing are emphasized.

GS 461 Personnel Management (3-0)3

A comprehensive study of modern labor management techniques in the recruiting, selection, training, and placement of members of the work force. Personnel administration agencies and procedures, with special attention to such matters as employee health and safety, welfare and recreation programs, wage and salary administration, training and education, and management relations with labor organizations.

GS 463 Business Law (3-0)3

The basic principles of commercial law including contracts, agency, sales, partnerships, corporation, negotiable instruments, bailments and carriers, insurance, personal property, real property, suretyship and guarantee, and bankruptcy.

GS 465 or 466 Management Problems (3-0)3
[Permission of Instructor]

Research for graduate students and selected seniors. Working under the guidance of the instructor, a student investigates an approved topic in the fields of finance, production, or distribution. The findings of the student are presented in formal thesis form. These theses are then placed in the department library for permanent record.

GS 468 — Business Finance — (2-0)2

The organization and financing of private enterprise, partnership, trust, and corporate types of business establishments. The stock and bond markets. Emphasis is placed on the study of the corporation in formation, operation, dissolution, and reorganization.

GS 469 — Comparative Modern Governments — (3-0)3

A study of twentieth century political thought and the structure and functions of government agencies in democratic and totalitarian political systems. Emphasis is given to new concepts of government authority and responsibility and to changing patterns of international relations.

GS 471 — American Foreign Policy, 1774 to the Present — (3-0)3

A study of the development of U. S. foreign policy from the beginnings of the Republic to our present position in world affairs. Particular attention is given to the influences of two world wars and their aftermaths upon American participation in global politics.

GS 473 — Modern Drama — (3-0)3

A survey of major forces in the theater from the time of Ibsen to the present. Selected representative plays of American and European dramatists are read and discussed.

GS 475 — The Modern American Novel — (3-0)3

A consideration of outstanding American novelists from 1920 to the present. Selected works of Faulkner, Fitzgerald, Hemingway, Wolfe, and others are read. Discussion of novels of war, satire, social protest, and "hard-boiled" realism.

LEATHER

LE 202 **Applied Leather Analysis** **(1-4)2**
[CH 213]

A subject designed to acquaint the student with the accepted methods of analysis of the American Leather Chemists Association and other supplementary procedures.

LE 301-302 **Leather Manufacture** **(3-6)(3-6)10**

Introduction to the technology of leather manufacture. The first semester is devoted to examining government regulations in imported hides and skins, studying the purchasing of hides and skins, and classifying various hide damages. This is followed by work on the handling of raw stock at the tannery, unhairing, bating, and hide classification. The second semester is concerned primarily with the study of vegetable tanning, chrome tanning, and various other types of tanning. In the work throughout the year the material covered in lectures is supplemented by laboratory studies on a small scale.

LE 303 **Leather Histology** **(2-4)4**
[CH 201-202]

A study of the structures of animal skin and of the changes which they undergo in the leather-making process. Because the basically extracellular nature of skin demands it, considerable time is devoted to the nature and function of the fundamental protein constituents.

LE 304 **Advanced Leather Histology** **(2-4)4**
[LE 303]

A study of the fibers of leather in their relationship primarily to the mechanisms of tanning and secondarily to pathological situations and to the physical characteristics of leather.

LE 401-402 **Leather Manufacture** **(3-6)(3-6)10**
[LE 302]

A continuation of the study into the technology of leather manufacture covering the various currying treatments applied to rough leather such as fat liquoring, stuffing, dyeing and the various mechanical operations of setting, stretching, etc. It is intended to show how widely the physical properties of leather may be varied and controlled by the proper application and selection of these numerous operations and treatments.

LE 404 — Properties of Leather — (2-3)3
[EN 351 and LE 401]

A practical and theoretical study of the characteristics of leather in relation to the end use. Studies are made on measuring and classifying the effect of changes in manufacturing procedure, both chemical and physical. Leather, because it is a natural product, varies considerably within the same hide. Thus, the nature of this variation is very important and the study of any changes affecting it is, in turn, important.

LE 405 — Leather Seminar — (1-0)1

A seminar on recent advances in leather research. Written and oral reports are required, and time is devoted to techniques of proper presentation of these reports.

LE 406 — Leather Seminar — (1-0)1

A continuation of LE 405.

LE 411-412 — Leather Problems — (1-6)(1-6)6
[LE 302]

This subject is designed primarily to enable the student to put into practical application the various scientific principles of physics, chemistry, mathematics, economics, etc. on problems of an industrial nature. This may encompass anything from the design and layout of any of a number of special leather plants to the suggested solution of practical problems which arise in the operation of a modern leather business.

MATHEMATICS

MA 101 **College Mathematics** **(4-0)4**

Algebra and plane trigonometry. Algebra review through quadratics, logarithms and simultaneous equations, functions of angles, solution of right triangles, the slide rule, and the use of approximate data.

MA 102 **College Mathematics** **(4-0)4**

Trigonometric equations and identities, solution of oblique triangles, Cartesian coordinates, equations of curves, algebraic derivatives and integrals.

MA 103 **College Mathematics** **(4-0)4**

Vectors, simultaneous equations, determinants, introduction to matrix concept, elements of trigonometry, elements of differentiation and integration. This subject is an expansion and extension of the student's high-school mathematics and is designed to accompany PH 103.

Text: Thomas, *Calculus and Analytic Geometry.*

MA 104 **College Mathematics** **(5-0)5**
[A grade of B or higher in MA 103]

An intensive study of the geometric properties and equations of curves, and the elements of differential and integral calculus. Stress is placed on the application of mathematics to problems in engineering. Topics studied include: graphical representation of functions; differentials and derivatives of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic and hyperbolic functions; integration of algebraic, trigonometric, exponential, and hyperbolic functions; analytic geometry of the straight line and conic sections; polar coordinates and parametric representation.

Texts: Thomas, *Calculus and Analytic Geometry;* Peirce, *A Short Table of Integrals.*

MA 201 **Analytic Geometry and Calculus** **(4-0)4**
[MA 102 or 104]

Differentiation of algebraic functions, maximum and minimum values, rates and differentials, the circle, parabola, ellipse, hyperbola, indefinite integrals, summation by integration, and applications of integration.

MA 202 **Analytic Geometry and Calculus** (3-0)3

[MA 201]

Applications of the fundamental theorem, diffentiation of transcendental functions, methods of integration, solid analytic geometry, polar coordinates, partial differentiation, and empirical formulas.

MA 206 **Differential Equations** (3-0)3

[MA 202]

A review of series and partial differentiation, first- and second-order differential equations, and first- and second-order partial differential equations. Practical applications for the chemist and the engineer.

MA 301-302 **Advanced Calculus** (3-0)(3-0)6

[MA 202]

Ordinary differential equations, Laplace transformation, numerical methods of solving differential equations, series solutions of differential equations, boundary value problems and orthogonal functions, vector analysis, partial differential equations, partial differential equations of mathematical physics, and complex variable theory.

MA 509 or 510 **Graphical Mathematics** (0-6)2

[EN 112 and MA 202]

Graphical solutions in algebra, differential and integral calculus, and in space geometry, with analytical verification; nomographs.

PAPER

PA 301 **Pulp Technology** **(3-0)3**
[CH 211]

Lectures and problems concerning the technology of pulp manufacture by the ground-wood, sulfite, alkaline and semi-chemical processes. Bleaching methods are studied.

PA 302 **Paper Technology** **(3-0)3**
[CH 211]

Lectures and problems concerning the technology of paper manufacture. Material covered includes stock preparation, filling and loading, sizing, coloring, special additives, paper machine operation, and finishing.

PA 303 **Pulp Laboratory** **(2-6)4**
[CH 211]

This as well as subsequent laboratory work is designed with a research-type approach to develop the student's ability to plan and analyze the experimental work and to reach logical conclusions from the results. Studies are made of the principle wood, rag and waste-paper pulps. The work includes wood and pulp microscopy, bleaching, and evaluations of pulps for their papermaking value by physical and chemical testing methods. Detailed written and oral reports are required.

PA 304 **Paper Laboratory** **(2-6)4**
[CH 211]

Studies of the fundamental processing techniques used in paper manufacture. The work includes investigations of stock preparation, filling and loading, coloring, use of additives, and sheet formation. Detailed written and oral reports are required.

PA 401-402 **Practice Work in Industry** **(1-8)(1-8)8**
[PA 302 and 304, or equivalent]

In order to give the student as thorough a knowledge of industrial problems and practices as possible, it is planned, in cooperation with several mills and converting plants, to set up practice stations. The student will spend one full day each week at one of these stations working on technical problems of interest to the mill management, but under the supervision of a member of the Institute staff. May be taken either or both semesters.

PA 403 **Converting Technology** **(3-0)3**

[PA 302 and 304]

Lectures and problems concerning the technology of paper and paperboard conversion by mechanical, coating, impregnating, laminating and printing processes.

PA 405 **Converting Laboratory** **(2-6)4**

[PA 403, usually taken concurrently]

Study of and practice in the use of the common techniques employed in the paper and paperboard industry. Emphasis is given to the colloidal and rheological properties of materials used. Detailed written and oral reports are required.

PA 408 or 409 **Mill Inspections** **(1-4)2**

Mill visits involving the observation of operations in various types of pulp, paper, paperboard, and converting mills. A formal, detailed written report of the observations made on each visit is required.

PA 413 or 414 **Paper Problems** **(2-6)4**

The senior is given an opportunity to work on a problem connected with some phase of the pulp, paperboard, or converting industry. Original application of accumulated knowledge of chemical and engineering principles is expected. Problems are selected by the student in collaboration with the staff and an advisory committee from the industry. One detailed formal report is required.

PA 501-502 **Graduate Thesis** **(1-9)(1-9)8**

Every graduate student is required to prove his ability to carry on independent research by presenting a thesis on an approved subject.

PA 503-504 **Plant Design** **(4-0)(4-0)8**

[PA 302, CH 333, CH 442]

Design of a paper, boardmaking, or converting process and plant. Included are the material and labor requirements, equipment selection (or design where commercial equipment is not available), the plant layout, and complete economic analysis. One detailed, formal written report including blueprints of equipment and plant layout is required. Principal reference texts: Vilbrandt, *Chemical Engineering Plant Design;* Tyler, *Chemical Engineering Economics.*

PA 505-506 Advanced Papermaking and Paper Converting (2-6) (2-6) 8

Non-fibrous raw materials used in the specialty papermaking and paper-converting fields with emphasis on recent developments and new uses. These materials are studied with regard to their chemical and physical properties, the technology of application and processed sheet properties.

PA 507-508 Graduate Seminar (1-0) (1-0) 0

Every graduate student is required to attend a weekly seminar with the staff. Student thesis progress, articles in recent literature, and unpublished recent developments in the field are discussed.

PHYSICS

PH 101 **Physics** **(4-0)3**

The basic principles of mechanics, including vector analysis, equilibrium of concurrent forces and non-concurrent rectilinear and curvilinear motion, inertia, harmonic motion, moment of inertia, conservation of energy, simple machines, hydro-statics and elements of hydraulics.

PH 102 **Physics** **(3-2)4**

[PH 101]

Electrostatics, direct-current circuits, magnetism, direct-current meters, induced electromotive force, capacitance and inductance, alternating-current circuits, electronics.

PH 103 **Physics** **(4-0)3**

Composition and resolution of vectors, statics, moments, center of gravity, rectilinear motion, Newton's second law, motion of a projectile, work and energy, impulse and momentum, circular motion, rotation, elasticity, harmonic motion, hydrostatics, hydrodynamics and viscosity.

Text: Sears and Zemansky, *College Physics* (Part I).

PH 104 **Physics** **(5-0)5**

[A grade of B or higher in MA 103 and PH 103]

Response of matter to temperature changes, conduction of heat, first and second laws of thermodynamics, wave motion and sound, electrostatics, direct-current circuits, magnetism, alternating-current circuits, electronics, optics, elements of atomic and nuclear physics.

Text: Sears and Zemansky, *University Physics* (Part II).

PH 201 **Physics** **(3-2)4**

[MA 102 or 104; PH 101 or 103]

Thermometry, measurement of heat, change of state, expansion, transfer of heat, humidity, first and second laws of thermodynamics, nature and propagation of light, reflection and refractions, lenses, optical instruments, illumination, color, interference and diffraction, polarization.

PH 202 **Physics** **(3-2)4**

[MA 102 or 104; PH 101 or 103]

Elasticity, hydrodynamics and viscosity, wave-motion and sound, elements of atomic and nuclear physics, spectra, x-rays, radioactivity, super-conductivity, relativity.

PH 204 **Optical Instruments** (3-2)4

[PH 202 taken concurrently]

The basic laws of optics and their application to various optical instruments used in industry, such as the microscope, telescope, refractometer, and colorimeter. Considerable emphasis in the laboratory work is placed on the general use of the microscope.

PH 301 or 302 Advanced General Physics Credit and hours to be arranged

[Permission of instructor]

Selected topics in mechanics, heat, sound, electricity, optics, and modern physics presented on an advanced level and emphasizing the interdependence of higher mathematics, classical physics, and practical concepts of engineering.

PH 321 or 322 **Electronics** *Tex. Eng.-Eng. Opt.* (2-2)3
Others (3-1)3

[PH 201]

The principles of alternating currents as a background for the understanding of electronic circuits. The elements of vacuum and gaseous tube characteristics and of circuits containing such tubes for the purpose of rectification, amplification, and oscillation. Industrial photoelectric relays, time delay relays, and Thymotrol motor controls.

PH 401 **Textile Microscopy** (2-3)3

[PH 202]

Applications of the microscope to textile materials. Methods of sectioning, measurement of cotton immaturity and mercerization, determination of denier of rayon, wool grading, fiber identification, quantitative analysis of fiber mixtures and their practical applications. Some of the more advanced aspects of critical microscopy which are essential for the best visual work and photographic practice are considered. Some time is devoted to photographic work and the use of polarized light.

PH 402 **Textile Physics** (2-2)3

[MA 201, PH 201 and 202]

Textile Physics is designed primarily for graduate students but may be taken by seniors who have sufficient knowledge of elementary college physics, microscopy and testing. It deals in an analytical and experimental manner with the principles of advanced physics which have important applications to textile technology. The topics taken up include heat transmission of textile materials; color measurements; calculation of tristimulus values; transforma-

tion to dominant wave-length, colorimetric purity and brightness; measurement of refractive index of fibers; applications of phase microscopy; fluorescent microscopy; use of X-ray diffraction methods to determine crystal orientation and structure of fibers; spectrographic analysis; investigation of mineral elements in textile fibers; and accurate methods of measuring stress, strain, viscosity.

PH 501 or 502 **The Physics of Color Measurement** **Credit and hours to be arranged**
[MA 202, PH 202]

The philosophy and practice of modern colorimetry. Colorimeters, their uses and limitations, spectrophotometers, tristimulus values, dominant wave-length and purity, the "standard observer" concept, the Munsell system, the Ostwald system, color tolerances, gloss and body color, illuminants, and industrial applications.

Laboratory instruments available consist of brightness testers, monochromatic and trichromatic colorimeters, recording and visual spectrophotometers.

PH 503 or 504 **Spectrographic Methods** **(2-2)3**
[PH 202]

The theory and application of the spectrograph for the qualitative and quantitative analysis of materials. The Bohr theory, quantum mechanics, atomic models, and the theoretical prediction of line and bend spectra. Special attention is placed in the laboratory on the analysis of elements in paper, leather, and textile samples and individual problems are assigned to the students.

PH 505 or 506 **X-Ray Diffraction** **(2-3)3**
[PH 202]

The theory of X-ray diffraction and its application to the structure of matter. Special consideration is given to the taking and interpretation of diffraction data obtained from fibers used in paper and textile technology.

PH 507 or 508 **Electron Microscopy** **(1-3)2**
[PH 202]

Basic methods in the practice of electron microscopy including specimen preparation, use and operation of the electron microscope, vacuum techniques, and photography. This work is supplemented with special studies on selected topics.

PLASTICS

PL 301-302 Introduction to Plastics Technology (3-3)(3-3)8

History, definitions, classes, properties, and applications of plastics. Raw materials and manufacturing processes. Methods of processing plastics materials including compounding, molding, casting, extruding, laminating, fabricating, and finishing. Evaluation and development of typical plastics problems. Laboratory instruction in the processing and fabrication of plastics materials.

PL 401-402 Advanced Plastics Technology (3-6)(3-6)10

[PL 301-302]

Not offered in 1956-1957

Applications of plastics as engineering materials. Study of important engineering properties, such as strength, flow, and resistance to chemicals, moisture, abrasion. Product, equipment and mold design. Correlation of composition, processing and fabricating with product design and applications. Continuation of laboratory instruction in processing and fabricating plastics. Use of testing equipment for evaluation of materials and end items. Standard A.S.T.M. tests for mechanical, thermal, electrical, and optical properties.

PL 411-412 Plastics Seminar (1-0)(1-0)2

Not offered in 1956-1957

Informal discussions of topics in, or related to, plastics engineering based on literature study conducted by the individual.

TEXTILES

TE 201-202 **Textile Fibers** (4-0)(3-0)7

A study of the important textile fibers, both natural and man-made. Classifications, origins, production, grading, marketing, and consumption. Stress is placed on their basic physical and chemical properties and their relationship to processing and utilization.

TE 203 **Textile Fibers** (4-0)4

Similar to TE 201-202, but less detailed. Not open to students in the Textile Manufacturing course.

TE 204 **Yarn Technology** (3-6)5

[TE 201]

The fundamental theory and practice of yarn manufacture by the cotton, woolen, worsted, and filament systems.

TE 206 **Yarn Manufacture** (3-3)4

[TE 203]

Similar to TE 204, but less detailed. Laboratory work consists of demonstrations only. Not open to students in the Textile Manufacturing course.

TE 211-212 **Color** (1-1)(1-1)2

A study of color, value and chroma using the Munsell color system. Several plates painted by the student show the application of color to textiles. These plates include perfected harmony and distribution in patterns illustrating stripes, checks, plaids, and decorative designs. The influence of colors upon one another is stressed.

TE 281-282 **Fashion Illustration** (0-2)(0-2)2

Illustration of garments on typical fashion figures, depicting all types of fabrics of various weights and textures.

TE 300 **Fabrics** (2-0)2

[Permission of instructor]

This subject is designed to acquaint the student with many of the important fabric types in use today for wearing apparel, home furnishings, and industrial uses. An analytical discussion is used so that the student may not only identify the fabrics but also understand the significance of the weave, design, yarns, etc., used.

TE 301-302 Yarn Technology (4-9)(4-9)14
[TE 204]

A continuation of TE 204.

TE 303-304 Fabric Technology (3-3)(3-3)8
[TE 301-302, taken concurrently]

The fundamental theory and practice relating to the design, construction and analysis of commercial fabrics, regardless of the fibers and/or yarns involved. Weaving and knitting, with their allied processing operations.

TE 307-308 Yarn Manufacture (3-3)(3-3)8
[TE 206]

A continuation of TE 206. Not open to students in the Textile Manufacturing course.

TE 309-310 Fabric Manufacture (2-2)(3-3)6
[TE 307-308, taken concurrently]

An abbreviated version of TE 303-304 and TE 401-402. Laboratory work consists of demonstrations only. Not open to students in the Textile Manufacturing course.

TE 311 Handloom Weaving (0-3)1

The handloom is used as the means of producing in a minimum amount of time many different fabric constructions, utilizing yarn of different diameters, types and color.

TE 319 History of Costume and Adaptions (1-2)2

A general coverage of typical costume through the ages from the early Egyptian to the present. The student is expected to make many modern adaptions inspired by period costumes.

TE 323 Surface Design Fundamentals (0-2)1

Fundamentals of surface design presented to develop an understanding of various surface patterns and rhythms for pleasing distribution of line and form.

TE 324 Applied Decorative Design (0-2)1
[TE 323]

Application of the fundamentals learned in TE 323 toward creation of surface patterns for prints and Jacquards.

TE 327-328 Elements of Textile Manufacture (3-3)(3-3)8

The elements of fiber preparation, yarn manufacture by all systems, weaving, and knitting. Laboratory consists of demonstrations only.

TE 352 **Fabric Draping** **(0-3)1**

The application of fabric to form for the purpose of understanding fully the use and limitations of various fabrics used in garments.

TE 401-402 **Fabric Technology** **(4-6)(5-9)14**

[TE 304]

Not offered in 1956-1957

A continuation of TE 303-304.

TE 403-404 **Textile Evaluation** **(2-2)(2-2)6**

[CH 102 and MA 102]

Not offered in 1956-1957

This subject is designed to provide a foundation for more advanced work in testing, and is of sufficient breadth to benefit those students whose main need is an understanding and appreciation of the scope of testing and evaluation in the textile industry. The subject matter covers an applied approach to the statistical treatment of experimental data, and the basic mechanical or physical, chemical, and optical tools and techniques available to the industry for product control, development, and evaluation. Primary emphasis is placed upon an understanding of the principles involved and an integration of the various phases of textile testing into a unified whole.

TE 405-406 **Textile Finishing** **(2-3)(2-3)6**

[CH 302 and TE 304 or 310]

Not offered in 1956-1957

Lectures and pilot plant laboratory work in all major physical and chemical operations necessary for the conversion into the finished state of all fabrics commonly used, regardless of fiber content.

TE 407 **Knitting** **(2-3)3**

[EN 102 and 112]

Similar to TE 419, but with less laboratory work.

TE 408 **Cotton and Synthetic Finishing** **(3-3)4**

[CH 321, CH 364, TE 300]

Similar to TE 421, but stressing the chemical, rather than the physical, aspects.

TE 409 **Woolen and Worsted Finishing** **(3-3)4**

[CH 102 or 104]

An abbreviated version of TE 423-424.

TE 411-412 Jacquard Design and Weaving (1-2)(1-2)4
[Permission of instructor]

Weaving on the Jacquard loom and the various tie-ups in common use. Instruction includes the sketching of original designs as applied to particular fabrics. The student is taught to transfer his original sketch to cross section design paper, to choose the proper weave for both the background and foreground, to cut cards and lace, and to weave the fabric.

TE 413 or 414 Jacquard Design (0-2)1
[Permission of instructor]

The student is taught to transfer a given motif to cross section paper, to choose the proper weave for the background and the foreground, and complete a Jacquard design. A sufficient number of cards are cut and laced to enable the student to appreciate the complete operation from the motif to the loom.

TE 415 Woolen and Worsted Mill Organization (4-0)4
[TE 316 and 322]

A recapitulation of the routine covered in previous wool textile manufacturing subjects. Mill layouts are organized to make definite yardages of specific fabrics using modern machinery by both the woolen and worsted systems of manufacture.

TE 417 Cotton Mill Organization (4-0)4
[TE 314]

This subject correlates all of the work on cotton manufacturing. Starting with a study of actual mill organizations the class is carried forward to problems in developing new organizations for specific types of products. The adaptations for long draft and for the handling of staple fibers are carefully covered. Calculations are made for the machinery necessary to keep plants in balance with some consideration of the best arrangements for economical handling.

TE 418 Management Problems (2-0)2
[TE 417]

Supplementary to TE 417. Job descriptions, job assignments and work load studies. Some time is spent considering arrangement of machinery for practical routing and operation, auxiliary equipment necessary and materials handling problems for efficient manufacturing.

TE 419 Knitting (2-5)4
[Permission of instructor]

A broad survey of the important types of knitting. Considerable stress is placed on the various stitches and the characteristics of

fabrics from each. Starting with flat machines, the work advances through small ribbers, automatic hosiery machines, full-fashioned hosiery machines, underwear machines and warp knitters. The production, design, and analysis of knit fabrics and the classifications and routines for manufacture of hosiery and underwear are included.

TE 421 Cotton and Synthetic Finishing (3-3)4
[CH 302, TE 300]

All the major physical and chemical operations necessary for the conversion into the finished state of staple gray cotton and synthetic fabrics are considered. In addition to inspection, singeing, desizing, padding, drying, calendering, curing, etc., the preliminary wet processing operations through dyeing are illustrated. Among the types of finishes employed are those of starching, softening, repelling, stabilizing, decating, etc., as well as the thermo-plastic and thermo-setting resins. The physical, rather than the chemical, aspects are stressed.

TE 422 Advanced Textile Design and Analysis (2-1)2
[Permission of instructor]

The first half of the semester is devoted to the study of Leavers Lace including history, manufacture, finishing, a detailed study of the Leavers machine, and the basic principles of lace design and drafting. The second half of the semester covers a study of embroideries and rugs. Schiffli embroidery includes the Schiffli machine, basic principles of Schiffli design, manufacturing, finishing and types and end uses of embroidery. Rugs include a study of the principles of construction and the analyses of Chenille, Wilton, Brussels, Tapestry, Velvet and Axminster carpets.

TE 423-424 Woolen and Worsted Finishing (2-3)(2-3)6
[CH 102]

A comprehensive introduction and orientation to the physical, rather than chemical, aspects of finishing including burling and mending, fulling, washing and speck dyeing, carbonizing, gigging, napping, steaming, singeing, crabbing, brushing, shearing, and pressing.

TE 426 Advanced Knitting (2-5)4
[TE 419]

This is an advanced subject for students who are specializing in knitting. With the approval of the department head, the student may select a particular field from the various sections of the knitting industry and concentrate on its problems.

TE 427-428 Properties and Applications of Synthetic Fibers (3-0)(3-0)6

[TE 312]

A continuation of TE 312. Much of the time will be spent on consideration of the fundamental properties of man-made fibers in relation to each other and to the behaviors of the finished textile resulting from these basic properties and the geometry imposed upon the fibers in the textile. To make the material more useful, comparisons are made with natural fibers and their textiles. Recent advances in the manufacture and study of fibers will be discussed.

TE 431 or 432 Advanced Weaving (2-3)3

[Permission of instructor]

Advanced work on the Crompton & Knowles looms, including the overhead multiplier, the filling mixer, and the tri-color automatic loom. Advanced work on the dobby looms, including Leno and Terry attachments. Other advanced areas such as Jacquard heads, harness mounting problems, and carpet weaving are also covered.

TE 433 Pattern Drafting (0-3)1

Not offered in 1956-1957

Methods of determining the parts of a pattern which form a basic plan for cutting a garment. Variations from the basic pattern are developed to show how changes occur.

TE 435 Woolen and Worsted Design (1-2)2

Not offered in 1956-1957

Analysis and construction of woolen and worsted fabrics.

TE 437 Weaving Laboratory (0-3)1

Not offered in 1956-1957

Application of theories learned in textile manufacturing classes.

TE 442 Fashion Design and Construction (0-3)1

Not offered in 1956-1957

Students are expected to originate and execute modern fashion silhouettes, by means of progressive steps, from drawing, through drafting, to the finished garment.

TE 444 Jacquard Design (1-2)2

Not offered in 1956-1957

Instruction includes work on original sketch, transfer to cross section paper, and indication of weave for background and foreground, in order to cut cards and lace for the Jacquard loom.

TE 501 or 502 — Methods of Research — (2-0)2

A seminar to familiarize the student with the philosophy and methods of research, current problems in textile research and the further use of textile literature.

TE 590-591 — Thesis Research — Credits and hours to be arranged

DEGREES CONFERRED IN 1955

Bachelor of Science

J. Joel Berger
*Roger Willard Bicknell
Norman G. Brodeur
William Thomas Brosnan
Peter Clement Canovai, Jr.
*Charles Koulias Chiklis
Daniel Francis Crean
Edward Kingston Dudgeon
Marcel Montcalm Dursin, Jr.
Robert George Eddy
Jules Saunders Eisenberg
Eric Francis Fagan
*†Donald William Frazee
*James Bernard Ganz
*Albert James Gilet, Jr.
Richard Francis Greeley
*Gerard Kennedy Green
Robert Ayer Hall
*Norman Alfred Hamel
Frank Raymond Hardy
Paul Anthony Harrington
Kenneth George Heintz
Archie Joseph Henry
Theodore Hoffman
Arnold Joseph Horowitz
Michael Ivanowicz
Edward Hugh Kane
Herbert Eugene Karp
Elaine Louise Kenney
Frank John Kiluk
Stuart N. Krouss
George Ernest Lanciault
Alan Hilton Langer
Stanley James Leavitt
Herbert Clark Lind
*Demetrios Speros Lolos
*Rodney Michel Madden
Vincent Joseph McKone
*John Joseph McNamara
Raymond A. Moissonnier
Albert Edward O'Heir
Guy Emmanual Perkins, Sr.
Albert C. Peterson
Leonard Howard Platnick
Henry Joseph Powell
Seymour Rekant
David Edman Riecks
Fernando Jose Robelo
Jerome Hirsch Rosen
*Clifton Rockwell Samson
Jayant K. Sanghrajka
George Aloysious Stanley
*James Edward Stanley
Stanley William Stein
Carl Alvin Stone
William Bernard Strzelewicz, Jr.
*David Francis Torchia
Fotine Velantzas
Robert Elliott Wagner
Robert Mahlon Walshaw
Charles Clifford Webster

Bachelor of Science with Honors

‡Piet Benno Bodenhorst
John Whitney Chapin
‡*Allen Charles Cohen
‡Raymond Leo Foye, Jr.
‡Floyd I. Frank
‡Nancy Jean Geary
‡*Charles Edward Hayes
‡Fred Domenic Iannazzi
‡Stergios George Katsaros
‡Donald Martin Legow
‡*Leon Missry
‡*Howard Davis Ponty
‡John Louis Twarog

---

*Commissioned Second Lieutenant in the United States Air Force Reserve

†Distinguished Military Graduate

‡Tau Epsilon Sigma (*Textile Scholastic Society*)

Master of Science

David H. Abrahams
Textile Chemistry
B.S., Lowell Technological Institute, 1953

Perry Horton Brown
Textile Engineering
B.S., Lowell Technological Institute, 1952

Alan Clifford Cate
Textile Engineering
B.S., Lowell Technological Institute, 1954

Donald Albert Cerow
Captain, United States Army
Textile Engineering
B.S., U. S. Military Academy, 1948

Gerald Raymond Escolas
Textile Chemistry
B.S., New Bedford Institute of Textiles and Technology, 1953

Thomas Francis Garvey
Textile Chemistry
B.S., Lowell Technological Institute, 1954

John William Gates, Jr.
Textile Chemistry
B.S., New Bedford Institute of Textiles and Technology, 1953

Victor Te-Chang Kao
Textile Engineering
B.S., Lowell Technological Institute, 1954

Veeriah Kota
Textile Chemistry
B.S., Osmania University, 1939
M.S., Osmania University, 1941
Ph. D., Osmania University, 1946
B.S., North Carolina State College, 1951

Andre Joseph Pelletier
Textile Chemistry
B.S., Lowell Technological Institute, 1954

Charles Philip Riley, Jr.
Textile Chemistry
B.S., Lowell Technological Institute, 1954

Charles Augustus Smith
Textile Chemistry
B.S., Lowell Technological Institute, 1954

DEGREES CONFERRED AS OF JANUARY 31, 1956

Bachelor of Science

Edward Jerome Adler
Ellsworth G. Mann, Jr.
Paul John Moser
Normand Bernard Ouellette

HONORARY DEGREES

Doctor of Science

Leonard Carmichael
The Secretary of the Smithsonian Institution

Jean Paul Mather
President, University of Massachusetts

Samuel Pinanski
President and Director, American Theatres Corporation
Chairman, Board of Trustees, Lowell Technological Institute

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August, 1956

BULLETIN

of the

Lowell Technological Institute of Massachusetts

LOWELL, MASS.

1956-1957

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Textile and Colonial Avenue

EVENING DIVISION

Publication of this Document Approved by George J. Cronin, State Purchasing Agent

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LORRAINE I. LEDOUX

Registrar
WALTER M. DROHAN, A.B., A.M.

CALENDAR—1956-1957

First Semester

September 10, 11, 18, 1956, 7-8:30 P.M.	Registration
September 24, 1956, Monday	Classes begin
October 12, 1956, Friday	Columbus Day, Holiday
November 12, 1956, Monday	Veterans Day, Holiday
November 21, 22, 23, 1956, Wednesday, Thursday and Friday	Thanksgiving Recess
December 24, 1956, Monday	Christmas Recess begins
January 7, 1957, Monday	Classes resume
January 18, 1957, Friday	End of First Semester

Second Semester

January 15, 16, 17, 1957, 7-8:30 P.M.	Registration
January 28, 1957, Monday	Classes begin
February 22, 1957, Friday	Washington's Birthday, Holiday
April 15, 1957, Monday	Easter Recess begins
April 22, 1957, Monday	Classes resume
May 17, 1957, Friday	End of Second Semester

FACULTY

CHEMISTRY

Prof. George R. Griffin, B.S., M.A., Ph.D., *Chairman of Division*
Prof. Allen Scattergood, A.B., Ph.D.
Assoc. Prof. Charles L. Daley, B.T.C.
Assoc. Prof. Charles L. Howarth, B.T.C.
Assoc. Prof. Ernest P. James, B.T.C., M.S.
Asst. Prof. Charles A. Everett, B.T.C.
Asst. Prof. Vasilis Lavrakas, B.S., M.S.
Asst. Prof. Walter J. Lisien, B.T.C.
Asst. Prof. Robert J. Peirent, B.S., M.S.
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Mr. Robert Morrison, B.S.

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Mr. Samuel J. Sabbagh, B.S.
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Mr. Royden Sharpe
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Mr. Chester Whitney

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Asst. Prof. Norwood H. Keeney, B.S., M.S.
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Mr. Charles Higgins, B.S.

Plastics Engineering

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Mr. A. C. Walker, B.S., M.S.
Mr. Raymond Normandin, A.B., M.S.

Rubber Engineering

Dr. Juan C. Montermoso

GENERAL STUDIES

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Mr. Thomas Higgins, B.A., M.A.
Mr. Francis K. Neilon, B.A., Ed.M.

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Mr. Frank Maria
Mr. Xenophon D. Michopoulos, A.B., M.A.
Mr. Charles G. Sampas, B.S.
Mr. Anthony Sousa

TEXTILE MANUFACTURING

Prof. Jacob K. Frederick, Jr., B.S., *Chairman of Division*

DESIGN, WEAVING, AND KNITTING

Prof. Vittoria Rosatto, B.S., *in charge*
Assoc. Prof. Edward L. Golec, B.S.
Assoc. Prof. Nathaniel E. Jones
Assoc. Prof. John L. Merrill, B.T.E.
Mrs. Lucy R. Weinbeck, B.T.E.
Mr. Albert T. Woidzik, B.S.

TEXTILE FINISHING

Prof. John J. McDonald, B.T.C., M.S., *in charge*
Assoc. Prof. Winford S. Nowell, B.M.E.

COTTON AND STAPLE SYNTHETIC YARNS

Assoc. Prof. John A. Goodwin, B.T.E., M.S., *in charge*
Asst. Prof. Clarence J. Pope, B.S., M.S.
Mr. Kenneth S. Merrill, B.S.

WOOL AND STAPLE SYNTHETIC YARNS

Asst. Prof. Russell L. Brown, B.S., *in charge*
Asst. Prof. J. Frederic Burtt, B.T.E.
Asst. Prof. Michael J. Koroskys, B.S., M.S.

GENERAL INFORMATION

Entrance Requirements

Entrance requirements vary with the subject selected. For subjects taken toward a certificate, the requirement, in general, is graduation from grammar school or equivalent education. For subjects taken for college credit, or toward an Associate Degree in Engineering, the requirement is graduation from a recognized high school or equivalent study or achievement.

Evidence of equivalent education, in place of grammar or high school graduation, may be given by presenting records of various courses taken elsewhere.

Conditioned Students

Applicants for the Associate Degree in Engineering who do not meet the full requirements for admission as regular students may, at the discretion of the Committee on Admissions, be admitted as conditioned students provided the secondary-school work completed embraces one unit of algebra.

A conditioned student whose scholarship is satisfactory but who has not removed his conditions within the time specified by the Committee on Admissions may be permitted to continue with his program of studies. However, on the completion of the chosen four-year curriculum he will receive a diploma rather than the Degree of Associate in Engineering.

Students who wish to register for single subjects in the engineering curriculum can do so provided they have the necessary prerequisites.

Registration

Students may register by filling out the necessary forms and paying fees before attending classes. Registration is held on the date indicated in the calendar. A student may register before the regular registration dates by presenting himself at the registrar's office from 9:00 A.M. to 4:00 P.M., Monday through Friday.

Classes are held on Monday, Tuesday, Wednesday, Thursday and Friday evenings each week, usually from 7:00 P.M. to 9:00 P.M., although other hours are sometimes required in particular subjects. Classes for those students taking courses toward an Associate Degree will be held from 7:00 P.M. to 9:30 P.M.

The scheduled nights for the various subjects in the following pages are tentative and may be altered in a few cases.

A student must have reached his sixteenth birthday before registering in the Evening Division, unless he has special permission from the Director of the Evening Division.

Late Registration

No new registrations or class changes will be accepted after the first two weeks of classes have been held, except with the permission of the Instructor involved and the Director of the Evening Division.

Registration Fee

A registration fee of one dollar per semester is required of all students, in addition to tuition and other charges.

Tuition for Subjects Not Carrying College Credit

Tuition for subjects not offering college credit is free to Lowell Technological Institute day students and residents of Lowell, but non-residents will be charged as follows:

Evenings Per Week	*Hours Per Evening*	*Tuition*
1	2	$ 5.00
1	2½	6.25
1	3	7.50
2	2	10.00
2	2½	12.50
2	3	15.00
3	2	15.00
3	2½	18.00
3	3	22.50

To receive free tuition, residents of Lowell must file a certificate of residence with the Registrar. These certificates may be obtained from the Election Commission, City Hall, Lowell. However, registration may be completed prior to filing the certificate.

Tuition for Subjects Carrying College Credit

All students working toward an Associate Degree as well as those students taking other subjects carrying college credit will be charged $9 per credit to a maximum of $25 per subject. However, college-level subjects may be taken without college credit at the rate charged for non-credit subjects. A student cannot take a college-credit subject at the regular rates and then apply for credit at the end of the term.

Tuition for Associate Degree Courses Only

Those students taking courses toward an Associate Degree will be charged the regular credit fee of $9 per credit up to a maximum of $25. The tuition fee for a class meeting 2½ hours per week is, therefore, $22.50 per semester or $45.00 a year.

Employees of Lowell Technological Institute

Employees of the Lowell Technological Institute and its Research Foundation are exempt from all tuition charges.

All Tuition and fees must be paid in full at the time of registration.

Occasionally situations arise which make it difficult to meet the payments of tuition and fees at the time of registration. Under such circumstances the student is advised to discuss his problem personally with the Director of the Evening Division.

Laboratory Fees

Students electing any Chemistry subject that requires laboratory work must pay a laboratory fee of $10 per semester in addition to their tuition. Those electing Machine Shop Practice must pay a laboratory fee of $5 per semester in addition to tuition. These fees are to cover supplies and normal breakage. Any excessive breakage will be billed directly to the student and must be paid before credit can be obtained. No portion of these laboratory fees will be returned except as provided in the section on refunds. These laboratory fee requirements apply to all students whether they are residents or non-residents of Lowell and whether they are studying for credit or non-credit.

Refunds

Students dropping out of a class any time before the end of the first two weeks may obtain a refund of 80% of their tuition and fees. Students dropping out of a class any time from the second to the fifth week may be refunded 50%

of their tuition and fees. There are no refunds after the fifth week of classes. A student must file an application for refund before one can be made. The registration fee of one dollar will not be returned in any case unless the class is cancelled.

Size of Class

No first-year subject will be given unless at least 15 students register for it. In a few instances, more than that number are required. Advanced subjects will usually, but not necessarily, be given, regardless of number.

Veterans

All L.T.I. Evening Division courses are approved for study under the G. I. Bill of Rights. World War II Veterans currently in training who have remaining educational entitlement may complete their program subject to V.A. regulations. Korean Veterans should make application for educational benefits at their Veterans Administration Office and secure a certificate of eligibility before registering. However, Korean Veterans will be required to pay the full tuition, laboratory and registration fees at the time of registration.

Books and Supplies

Students must provide their own books, paper, and drawing materials, and pay for any breakage or damage of school equipment that they may cause.

Student supplies will be sold by the school cooperative store each school evening from 6:45 P.M. to 8:15 P.M.

Inclement Weather

Due to difficulties in notifying in time students and instructors who reside at a distance, evening school will not be cancelled for reasons of weather at any time.

Attendance

Students must attend 70% of classes held in order to receive a certificate for the subject. Four unexplained absences in a row will result in the student being automatically dropped from the rolls.

Students in college-credit and Associate Degree courses must attend 80% of all classes.

Credits

Subjects considered of college level are indicated in the subject descriptions and credit hours are assigned to them. A high-school diploma is a prerequisite for all college-level courses.

Grading System

The following system of grading is used:

A	90 - 100	Excellent
B	80 - 89	Good
C	70 - 79	Fair
D	60 - 69	Lowest Passing Grade
F	50 - 59	Failure
W	Withdrawn	
X	Dropped	

Please note that no student will be permitted to graduate from the Associate Degree courses with less than a "C" average.

CHEMISTRY

First Semester Subjects (Sept. - Jan.)

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
College Chemistry	CH-101	Mon., Tues. & Thurs.	C-2
General Chemistry	C-1	To Be Arranged	None
General Colloid Chemistry	C-15	To Be Arranged	C-6
High Polymer Lab.	C-11-13	To Be Arranged	C-10
Organic Chemistry	C-5	To Be Arranged	C-2
Organic High Polymer Chemistry	C-9	To Be Arranged	C-8
Physical Chemistry	C-7	To Be Arranged	C-4, M-6
Qualitative Analysis	C-3	To Be Arranged	C-2
Textile Chemistry & Dyeing	C-23	Mon., Tues. & Thurs.	C-39
Textile Chemistry & Dyeing	C-25	Mon., Tues. & Thurs.	C-24

Second Semester Subjects (Jan. - May)

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
College Chemistry	CH-102	Mon., Tues. & Thurs.	CH-101
General Chemistry	C-2	To Be Arranged	C-1
General Colloid Chemistry	C-16	To Be Arranged	C-15
High Polymer Lab.	C-12-14	To Be Arranged	C-11
Organic Chemistry	C-6	To Be Arranged	C-5
Physical Chemistry	C-8	To Be Arranged	C-7
Physical Chemistry of High Polymers	C-10	To Be Arranged	C-9
Quantitative Analysis	C-4	To Be Arranged	C-3
Technology of Fibers	C-39	Tues. & Thurs.	C-38
Textile Chemistry & Dyeing	C-24	Mon., Tues. & Thurs.	C-23
Textile Chemistry & Dyeing	C-26	Mon., Tues. & Thurs.	C-25

ENGINEERING

First Semester Subjects (Sept. - Jan.)

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
A.C. Machinery Lab.	E-1	To Be Arranged	E-6
Advanced Electronic Lab. 1	E-3	To Be Arranged	E-113, 115 Concurrently
Algebra	E-5	To Be Arranged	E-7
Algebra	E-7	Mon. & Wed.	None
Algebra	E-9	Mon. & Wed.	E-7
Analytical Geometry and	E-11	E-11, 13 Taken Concurrently	E-114
Differential Calculus	E-13	To Be Arranged	E-11
Applied Leather Analysis	E-15	To Be Arranged	C-6
Applied Mathematics	E-17	Mon. & Wed.	None
Applied Mechanics	E-19	To Be Arranged	E-114, E-99
Architectural Drawing	E-21	Tues. & Thurs.	E-73
Architectural Drawing	E-23	Tues. & Thurs.	E-21
Blueprint Reading	E-25	Mon. & Wed.	None
Analytical Geometry and Calculus	E-27	Tues. & Thurs.	E-114
D.C. Machinery	E-29	To Be Arranged	E-33
D.C. Machinery Lab.	E-31	To Be Arranged	E-29
D.C. Theory	E-33	To Be Arranged	E-114
Electronics	E-35	Mon. & Wed.	College Math. & Physics
Electronics for Industry	E-37	To Be Arranged	E-114, E-29
Electronic Physics	E-39	To Be Arranged	E-90
Electron Tubes & Circuits	E-41	To Be Arranged	E-33, E-10
Electrical Measurements	E-43	To Be Arranged	E-52, E-33, 10
Engineering Drawing	E-45	To Be Arranged	None
Fundamentals of Electronics	E-47	Tues. & Thurs.	E-10
Fundamentals of Plastics	E-49	Monday	None
Geometry of Engineering Drawing	E-51	Tues. & Thurs.	E-77, E-23
Heat Engineering	E-53	To Be Arranged	E-99, E-90
Job Evaluation and Merit Rating	E-55	To Be Arranged	None
Leather Technology	E-57	To Be Arranged	C-6
Leather Technology	E-59	To Be Arranged	E-56
Leather Technology	E-61	Tues. & Thurs.	None
Machine Shop Practice	E-63	Mon. or Wed.	None
Machine Shop Practice	E-65	Tues & Thurs.	E-63
Machine Design	E-67	To Be Arranged	E-123, E-108
Machine Drawing	E-69	To Be Arranged	E-38
Mechanical Drawing	E-71	Mon. & Wed.	None
Mechanical Drawing	E-73	Tues. & Thurs.	E-71
Mechanical Drawing	E-75	Tues. & Thurs.	E-73
Mechanical Drawing	E-77	Tues. & Thurs.	E-75
Mechanical Engineering Lab.	E-79	To Be Arranged	E-46, E-53
Mechanism	E-81	To Be Arranged	E-68, E-69
Mechanism	E-83	Tues. & Thurs.	None
Oil Heating	E-85	Mon. & Wed.	None
Paper Technology	E-87	To Be Arranged	C-6
Paper Technology	E-89	To Be Arranged	E-84
Paper Manufacturing—Testing and Analysis	E-91	To Be Arranged	C-6

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
Paper Manufacturing—Testing and Analysis	E-93	To Be Arranged	E-80
Physical Testing of Leather	E-95	To Be Arranged	E-54
Physics	E-97	Tues. & Thurs.	E-17
Physics	E-99	To Be Arranged	E-97
Plastic Technology	E-103	To Be Arranged	C-6
Plastic Technology	E-105	To Be Arranged	E-92
Pulp and Paper Technology	E-107	Tuesday	None
Pulp and Paper Testing Lab.	E-109	Wednesday	E-107 Concurrently
Quality Control	E-111	Tues. & Thurs.	None
Communication Engineering	E-115	To Be Arranged	E-36
Rubber Technology	E-117	To Be Arranged	C-6
Rubber Technology	E-119	To Be Arranged	E-102
Steam	E-121	Mon. & Wed.	None
Strength of Materials	E-123	To Be Arranged	E-18, E-19, E-52
Textile Testing	E-125	Tues. & Thurs.	None
Time Study	E-127	To Be Arranged	None
Trigonometry	E-129	Tues. & Thurs.	E-16

Second Semester Subjects (Jan. - May)

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
Advanced Electronic Lab. II	E-2	To Be Arranged	E-40 Concurrently
Advanced Paper Technology	E-4	Tuesday	E-107
A.C. Machinery	E-6	To Be Arranged	E-10
A.C. Machinery Lab.	E-8	To Be Arranged	E-6
A.C. Theory	E-10	To Be Arranged	E-33
Air Conditioning—Heating & Ventilation	E-12	Mon. & Wed.	E-17, E-88
Algebra	E-14	Mon. & Wed.	None
Algebra	E-16	Mon. & Thurs.	E-14
Applied Mechanics	E-18	To Be Arranged	E-99, E-114
Architectural Drawing	E-21	Tues. & Thurs.	E-73
Architectural Drawing	E-23	Tues. & Thurs.	E-21
Blueprint Reading	E-24	Mon. & Wed.	None
Analytical Geometry and Calculus	E-26	Tues. & Thurs.	E-27
Chemistry of Plastics	E-28	To Be Arranged	Col. Chem. thru Org.
Diesel Engines	E-30	Mon. & Wed.	None
Electronics for Industry Lab.	E-32	To Be Arranged	E-37
Electronic Lab.	E-34	To Be Arranged	E-36 Concurrently
Electron Tubes and Circuits	E-36	To Be Arranged	E-41
Engineering Drawing	E-38	To Be Arranged	E-45
Frequency Modulation and Television	E-40	To Be Arranged	E-113, E-115
Fundamentals of Electronics	E-42	Mon. & Wed.	E-10
Geometry of Engineering Drawing	E-44	Tues. & Thurs.	E-51
Heat Engineering	E-46	To Be Arranged	E-99, E-90
Hydraulics	E-48	To Be Arranged	E-18, E-19
Industrial Electronics	E-50	Tues. & Thurs.	E-47
Integral Calculus	E-52	To Be Arranged	E-13
Leather Histology	E-54	To Be Arranged	E-15
Leather Technology	E-56	To Be Arranged	E-57
Leather Technology	E-58	To Be Arranged	E-59
Leather Technology	E-60	Tues. & Thurs.	E-61

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
Machine Shop Practice	E-63	Mon. or Wed.	None
Machine Shop Practice	E-65	Tues. & Thurs.	E-63
Machine Design	E-66	To Be Arranged	E-108, E-123
Machine Drawing	E-68	To Be Arranged	E-38, E-45
Mechanical Drawing	E-71	Mon. & Wed.	None
Mechanical Drawing	E-73	Mon. & Wed.	E-71
Mechanical Drawing	E-75	Tues. & Thurs.	E-73
Mechanical Drawing	E-77	Tues. & Thurs.	E-75
Mechanical Engineering Lab.	E-78	To Be Arranged	E-46, E-53
Paper Manufacturing—Testing and Analysis	E-80	To Be Arranged	E-91
Paper Manufacturing—Testing and Analysis	E-82	To Be Arranged	E-93
Paper Technology	E-84	To Be Arranged	E-87
Paper Technology	E-86	To Be Arranged	E-89
Physics	E-88	Tues. & Thurs.	E-17
Physics	E-90	To Be Arranged	E-99
Plastic Technology	E-92	To Be Arranged	E-103
Plastic Technology	E-94	To Be Arranged	E-105
Principles of Production and Planning	E-96	To Be Arranged	None
Principles of Radio	E-98	Mon. & Wed.	E-47
Research Problems in Leather	E-100	To Be Arranged	E-95
Rubber Technology	E-102	To Be Arranged	E-117
Rubber Technology	E-104	To Be Arranged	E-119
Semi-Conductors & Transistors	E-106	To Be Arranged	E-33, E-39
Strength of Materials	E-108	To Be Arranged	E-18, 19, E-52
Strength of Materials	E-110	Mon. & Wed.	None
Transmission and Distribution Theory	E-112	To Be Arranged	E-6
Trigonometry	E-114	To Be Arranged	E-5
Trigonometry	E-116	Tues. & Thurs.	E-14
Work Simplification	E-118	To Be Arranged	None

ELECTRICAL ENGINEERING

Leading to the Degree of Associate in Engineering

FIRST YEAR

First Semester Course No.	COURSE	Class Hours	Second Semester Course No.	COURSE	Class Hours
E-5	Algebra	2½	E-114	Trigonometry	2½
E-45	Engineering Drawing	2½	E-38	Engineering Drawing	2½
E-99	Physics I	2½	E-90	Physics II	2½
		7½			7½

SECOND YEAR

E-11	Analytical Geometry	2½			
E-13	Differential Calculus		E-52	Integral Calculus	2½
E-33	D-C Theory	2½	E-10	A-C Theory	2½
E-19	Applied Mechanics I	2½	E-18	Applied Mechanics II	2½
		7½			7½

THIRD YEAR

E-123	Strength of Materials	2½	E-108	Strength of Materials	2½
E-29	D-C Machinery	2½	E-6	A-C Machinery	2½
E-31	D-C Machinery Lab.	2½	E-8	A-C Machinery Lab. I	2½
		7½			7½

FOURTH YEAR

E-37	Electronics for Industry	2½	E-112	Transmission Theory	2½
E-53	Heat Engineering	2½	E-46	Heat Engineering	2½
E-1	A-C Machinery Lab. II	2½	E-32	Electronics for Industry Lab.	2½
		7½			7½

ELECTRONIC ENGINEERING

Leading to the Degree of Associate in Engineering

FIRST YEAR

Course No.	First Semester COURSE	Class Hours	Course No.	Second Semester COURSE	Class Hours
E-5	Algebra	2½	E-114	Trigonometry	2½
E-45	Engineering Drawing	2½	E-38	Engineering Drawing	2½
E-99	Physics I	2½	E-90	Physics II	2½
		7½			7½

SECOND YEAR

E-11	Analytical Geometry	2½	E-52	Integral Calculus	2½
E-13	Differential Calculus		E-10	A-C Theory	2½
E-33	D-C Theory	2½	E-106	Semi-Conductors and Transistors	2½
E-39	Electronic Physics	2½			
		7½			7½

THIRD YEAR

E-41	Electron Tubes and Circuits I	5	E-36	Electron Tubes and Circuits II	5
E-43	Electrical Measurements	2½	E-34	Electronic Lab.	2½
		7½			7½

FOURTH YEAR

E-27A	Communication Engineering	5	E-40	Frequency Modulation and Television	5
E-3	Advanced Electronic Lab. I	2½	E-2	Advanced Electronic Lab. II	2½
		7½			7½

INDUSTRIAL ENGINEERING

Leading to the Degree of Associate in Engineering

FIRST YEAR

First Semester Course No.	COURSE	Class Hours	Second Semester Course No.	COURSE	Class Hours
E-5	Algebra	2½	E-114	Trigonometry	2½
E-45	Engineering Drawing	2½	E-38	Engineering Drawing	2½
E-99	Physics I	2½	E-90	Physics II	2½
		7½			7½

SECOND YEAR

E-11	Analytical Geometry	2½			
E-13	Differential Calculus		E-52	Integral Calculus	2½
E-19	Applied Mechanics	2½	E-18	Applied Mechanics	2½
E-69	Machine Drawing	2½	E-68	Machine Drawing	2½
		7½			7½

THIRD YEAR

E-123	Strength of Materials	2½	E-108	Strength of Materials	2½
E-55	Job Evaluation and Merit Rating	2½	E-118	Work Simplification	2½
E-53	Heat Engineering	2½	E-46	Heat Engineering	2½
		7½			7½

FOURTH YEAR

E-67	Machine Design	2½	E-66	Machine Design	2½
E-127	Time Study	2½	E-96	Principles of Production Planning	2½
	Engineering Elective	2½		Engineering Elective	2½
		7½			7½

LEATHER ENGINEERING

LEADING TO THE DEGREE OF ASSOCIATE IN ENGINEERING

FIRST YEAR

First Semester Course No.	COURSE	Class Hours	Second Semester Course No.	COURSE	Class Hours
E-5	Algebra	2½	E-114	Trigonometry	2½
C1	General Chemistry	2½	C2	General Chemistry	2½
C1-L	General Chemistry Lab.	2½	C2-L	General Chemistry Lab.	2½
		7½			7½

SECOND YEAR

Course No.	COURSE	Class Hours	Course No.	COURSE	Class Hours
E-99	Physics	2½	E-99	Physics	2½
C3	Qualitative Chemistry	2½	C4	Quantitative Chemistry	2½
C3-L	Qualitative Chemistry Lab.	2½	C4-L	Quantitative Chemistry Lab.	2½
		7½			7½

THIRD YEAR

Course No.	COURSE	Class Hours	Course No.	COURSE	Class Hours
E-11	Analytical Geometry	2½			
E-13	Differential Calculus		E-52	Integral Calculus	2½
C5	Organic Chemistry	2½	C6	Organic Chemistry	2½
C5-L	Organic Chemistry Lab.	2½	C6-L	Organic Chemistry Lab.	2½
		7½			7½

FOURTH YEAR

Course No.	COURSE	Class Hours	Course No.	COURSE	Class Hours
C7	Physical Chemistry	2½	C8	Physical Chemistry	2½
E-15	Applied Leather Analysis	2½	E-54	Leather Histology	2½
E-57	Leather Technology	2½	E-56	Leather Technology	2½
		7½			7½

FIFTH YEAR

Course No.	COURSE	Class Hours	Course No.	COURSE	Class Hours
E-59	Leather Technology	2½	E-58	Leather Technology	2½
E-95	Physical Testing of Leather	2½	E-100	Research Problems in Leather	2½
		5			5

MECHANICAL ENGINEERING

LEADING TO THE DEGREE OF ASSOCIATE IN ENGINEERING

FIRST YEAR

First Semester Course No.	COURSE	Class Hours	Second Semester Course No.	COURSE	Class Hours
E-5	Algebra	2½	E-114	Trigonometry	2½
E-45	Engineering Drawing	2½	E-38	Engineering Drawing	2½
E-99	Physics I	2½	E-90	Physics II	2½
		7½			7½

SECOND YEAR

E-11	Analytical Geometry	2½			
E-13	Differential Calculus		E-52	Integral Calculus	2½
E-69	Machine Drawing	2½	E-68	Machine Drawing	2½
E-19	Applied Mechanics	2½	E-18	Applied Mechanics	2½
		7½			7½

THIRD YEAR

E-123	Strength of Materials	2½	E-108	Strength of Materials	2½
E-81	Mechanism	2½	E-48	Hydraulics	2½
E-53	Heat Engineering	2½	E-46	Heat Engineering	2½
		7½			7½

FOURTH YEAR

E-67	Machine Design	2½	E-66	Machine Design	2½
E-79	Mechanical Engineering Lab.	2½	E-78	Mechanical Engineering Lab.	2½
	Engineering Elective	2½		Engineering Elective	2½
		7½			7½

PAPER ENGINEERING

Leading to the Degree of Associate in Engineering

FIRST YEAR

First Semester Course No.	COURSE	Class Hours	Second Semester Course No.	COURSE	Class Hours
E-5	Algebra	2½	E-114	Trigonometry	2½
C1	General Chemistry	2½	C2	General Chemistry	2½
C1-L	General Chemistry Lab.	2½	C2-L	General Chemistry Lab.	2½
		7½			7½

SECOND YEAR

E-99	Physics	2½	E-90	Physics	2½
C3	Qualitative Chemistry	2½	C4	Quantitative Chemistry	2½
C3-L	Qualitative Chemistry Lab.	2½	C4-L	Quantitative Chemistry Lab.	2½
		7½			7½

THIRD YEAR

E-11	Analytical Geometry	2½	E-52	Integral Calculus	2½
E-13	Differential Calculus		C6	Organic Chemistry	2½
C5	Organic Chemistry	2½	C6-L	Organic Chemistry Lab.	2½
C5-L	Organic Chemistry Lab.	2½			
		7½			7½

FOURTH YEAR

C7	Physical Chemistry	2½	C8	Physical Chemistry	2½
E-87	Paper Technology	2½	E-84	Paper Technology	2½
E-91	Paper Manufacturing—Testing and Analysis	2½	E-80	Paper Manufacturing—Testing and Analysis	2½
		7½			7½

FIFTH YEAR

E-89	Paper Technology	2½	E-86	Paper Technology	2½
E-93	Paper Manufacturing—Testing and Analysis	2½	E-82	Paper Manufacturing—Testing and Analysis	2½
C15	General Colloid Chemistry	2½	C16	General Colloid Chemistry	2½
		7½			7½

PLASTICS ENGINEERING

LEADING TO THE DEGREE OF ASSOCIATE IN ENGINEERING

FIRST YEAR

First Semester			Second Semester		
Course No.	COURSE	Class Hours	Course No.	COURSE	Class Hours
E-5	Algebra	2½	E-114	Trigonometry	2½
C1	General Chemistry	2½	C2	General Chemistry	2½
C1-L	General Chemistry Lab.	2½	C2-L	General Chemistry Lab.	2½
		7½			7½

SECOND YEAR

E-99	Physics	2½	E-90	Physics	2½
C3	Qualitative Chemistry	2½	C4	Quantitative Chemistry	2½
C3-L	Qualitative Lab.	2½	C4-L	Quantitative Lab.	2½
		7½			7½

THIRD YEAR

E-11	Analytical Geometry	2½	E-52	Integral Calculus	2½
E-13	Differential Calculus		C6	Organic Chemistry	2½
C5	Organic Chemistry	2½	C6-L	Organic Chemistry Lab.	2½
C5-L	Organic Chemistry Lab.	2½			
		7½			7½

FOURTH YEAR

C7	Physical Chemistry	2½	C8	Physical Chemistry	2½
C9	Organic High Polymer Chemistry	2½	C10	Physical Chemistry of High Polymers	2½
E-103	Plastic Technology	2½	E-92	Plastic Technology	2½
		7½			7½

FIFTH YEAR

C11	High Polymer Lab.	2½	C12	High Polymer Lab.	2½
E-105	Plastic Technology	2½	E-94	Plastic Technology	2½
		5			5

RUBBER ENGINEERING

LEADING TO THE DEGREE OF ASSOCIATE IN ENGINEERING

FIRST YEAR

First Semester Course No.	COURSE	Class Hours	Second Semester Course No.	COURSE	Class Hours
E-5	Algebra	2½	E-114	Trigonometry	2½
C1	General Chemistry	2½	C2	General Chemistry	2½
C1-L	General Chemistry Lab.	2½	C2-L	General Chemistry Lab.	2½
		7½			7½

SECOND YEAR

Course No.	COURSE	Class Hours	Course No.	COURSE	Class Hours
E-99	Physics	2½	E-90	Physics	2½
C3	Qualitative Chemistry	2½	C4	Quantitative Chemistry	2½
C3-L	Qualitative Lab.	2½	C4-L	Quantitative Lab.	2½
		7½			7½

THIRD YEAR

Course No.	COURSE	Class Hours	Course No.	COURSE	Class Hours
E-11	Analytical Geometry	2½	E-52	Integral Calculus	2½
E-13	Differential Calculus		C6	Organic Chemistry	2½
C5	Organic Chemistry	2½	C6-L	Organic Chemistry Lab.	2½
C5-L	Organic Chemistry Lab.	2½			
		7½			7½

FOURTH YEAR

Course No.	COURSE	Class Hours	Course No.	COURSE	Class Hours
C7	Physical Chemistry	2½	C8	Physical Chemistry	2½
C9	Organic High Polymer Chemistry	2½	C10	Physical Chemistry of High Polymers	2½
E-102	Rubber Technology	2½	E-117	Rubber Technology	2½
		7½			7½

FIFTH YEAR

Course No.	COURSE	Class Hours	Course No.	COURSE	Class Hours
C11	High Polymer Lab.	2½	C12	High Polymer Lab.	2½
E-104	Rubber Technology	2½	E-119	Rubber Technology	2½
		5			5

GENERAL STUDIES

First Semester Subjects (Sept. - Jan.)

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
Accounting I	G-1	Mon. & Wed.	None
Appreciation of World Literature	G-3	Tues. & Thurs.	None
Backgrounds of Latin America	G-5	Monday	None
Business Law	G-7	Tues. & Thurs.	None
Contemporary World Problems	G-9	Wed. & Fri.	None
Cost Accounting	G-11	Monday	G-2
Costume Design	G-13	Tues. & Thurs.	None
English Composition	G-15	Tues. & Thurs.	None
Fashion Illustration	G-17	Tues. & Thurs.	G-19
Foremanship	G-19	Mon. & Wed.	None
Freehand Drawing	G-21	Mon. & Wed.	None
Freehand Drawing	G-21	Tues. & Thurs.	None
Fundamentals of Public Relations	G-23	Monday	None
Great English and American Writers	G-25	Monday	1 Year College English
Industrial Psychology	G-27	Wed. & Fri.	None
Industrial Relations	G-29	Tues. & Thurs.	None
Main Currents in Modern Drama	G-31	Tues. & Thurs.	1 Year College English
Principles of Advertising	G-33	Tues. & Thurs.	None
Principles of Retailing	G-35	Tues. & Wed.	None
Principles of Salesmanship	G-37	Tues. & Wed.	None
Psychology	G-39	Mon. & Wed.	None
Show Card Design	G-41	Mon. & Wed.	None
Silk Screen Printing	G-43	Tues. & Thurs.	None
United States History Since 1865	G-45	Wednesday	None
Vocabulary Building	G-47	Mon. & Wed.	None
Writing for Profit	G-49	Mon. & Thurs.	None

Second Semester Subjects (Jan. - May)

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
Accounting II	G-2	Mon. & Wed.	G-1
Appreciation of World Literature	G-4	Tues. & Thurs.	None
American Foreign Policy	G-6	Wednesday	None
Comparative Literature	G-8	Monday	1 Year College Lit.
Costume Design	G-10	Mon. & Wed.	G-13
Current Affairs	G-12	Wed. & Fri.	None
Delinquency and Crime	G-14	Wed. & Fri.	None
English Composition	G-16	Tues. & Thurs.	G-17
Freehand Drawing	G-21	Mon. & Wed.	None
Foremanship	G-19	Tues. & Thurs.	None
Forces in Modern English and American Drama	G-22	Tues. & Thurs.	1 Year College English
Life Drawing	G-24	Tues. & Thurs.	G-23
Meaning and Use of Words	G-26	Mon. & Wed.	None
Modern Latin America	G-28	Monday	None

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
Pastel Drawing	G-30	Tues. & Thurs.	G-23
Principles of Retailing	G-35	Tues. & Wed.	None
Principles of Salesmanship	G-37	Tues. & Wed.	None
Show Card Design	G-36	Mon. & Wed.	G-14
Techniques of Leadership	G-38	Tues. & Thurs.	None
Water Color	G-40	Tues. & Thurs.	None

TEXTILE MANUFACTURING

First Semester Subjects (Sept. - Jan.)

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
Cotton Design	M-28	Tues. & Thurs.	M-27
Cotton Yarns	M-11	Tues. & Thurs.	None
Cotton Yarns	M-13	Mon. & Wed.	M-12
Elementary Textile Design	M-51	Mon. & Wed.	None
Knitting	M-15	Tues. & Thurs.	None
Loom Fixing	M-24	Tues. & Thurs.	M-33
Power Weaving	M-33	Mon. & Wed.	None
Power Weaving and Warp Preparation	M-32	Tues. & Thurs.	None
Reprocessed and Reused Fiber Manufacture	M-3B	Mon.	M-1 (or equivalent) & M-2
Synthetic Yarn Manufacture on Woolen System	M-3C	Tues.	M-3A
Technology of Natural and Man-made Fibers	M-2	Mon. & Tues.	None
Textile Mechanism and Calculations	M-1	Thurs.	None
Top Mill Organization	M-8	Thurs.	M-4
Woolen & Worsted Design	M-30	Tues. & Thurs.	M-29
Woolen & Worsted Finishing	M-10	Mon. & Wed.	None
Worsted & Synthetic Yarn Manufacturing	M-5	Wed. & Thurs.	M-4

Second Semester Subjects (Jan. - May)

SUBJECT	NUMBER	EVENINGS	PRE-REQUISITE
Cotton & Synthetic Design	M-27	Mon. & Wed.	M-51
Cotton & Synthetic Finishing	M-18	Mon. & Wed.	C-38 & M-51
Cotton Yarns	M-12	Tues. & Thurs.	M-11
Synthetic Yarn Manufacture on the Cotton System	M-14	Mon. & Wed.	M-13
Tow to Top-Synthetic and Man-made Fiber	M-7	Thurs.	M-4
Wool & Staple Synthetic French Combing	M-6A	Thurs.	M-4
Wool & Staple Synthetic Top Manufacture	M-4	Mon. & Tues.	M-1 (or equivalent) & M-2
Wool & Staple Synthetic Yarn Manufacture on the French System	M-6B	Wed.	M-4
Woolen Design	M-29	Mon. & Wed.	M-51
Yarn Manufacturing by Woolen System	M-3A	Mon. & Tues.	M-1 (or equivalent) & M-2

COURSE DESCRIPTIONS

C-1 and C-2 General Chemistry. Two semesters of basic Inorganic Chemistry for those with no previous knowledge of Chemistry. The fundamental laws of Chemistry; the preparation, properties and uses of metals, non-metals and related compounds; and simple chemical calculations. One lecture, 7–9:30 P.M., and one laboratory, 7–9:30 P.M., per week. 10 credits.

C-3 Qualitative Analysis. The systematic analysis of inorganic compounds, carried out by the student in the laboratory using semi-micro technique. Chemical calculations and the balancing of chemical equations are covered in the stoichiometry portion of the course. One lecture, 7–9:30 P.M., and one laboratory, 7–9:30 P.M., per week. 5 credit hours.

C-4 Quantitative Analysis. One semester of quantitative analysis for those not desiring college credit in Chemistry but who wish to develop laboratory skills and techniques of a practical nature. One lecture, 7–9:30 P.M., and one laboratory, 7–9:30 P.M., per week. 5 credits.

C-5 and C-6 Organic Chemistry. A study of the important classes of carbon compounds and the fundamental theories of Organic Chemistry. Lecture, 7–9:30 P.M., Laboratory, 7–9:30 P.M. 10 credits.

C-7 and C-8 Physical Chemistry. This subject is designed for those in the laboratory or industry. It includes a discussion of properties of gases, liquids, solids, and solutions; chemical equilibrium, phase equilibrium, thermochemistry, electrochemistry, and other topics according to the need of the students. Laboratory work is assigned as required to give the student practice in the methods and apparatus of Physical Chemistry. Laboratory work includes the measurement of vapor pressure, viscosity, surface tension, heat of combustion and reaction, conductivity, determination of molecular weight, pH by various methods, etc. Lecture, 7–9:30 P.M. 5 credits.

C-9 and C-10 High Polymer Chemistry. The chemical structure of high polymers and their manufacture and preparation. The chemical reactions of plastics and their physical properties in relation to their chemical structure. This subject is designed for those in the plastics industry who desire to keep abreast of modern theory or broaden their background. Lecture, 7–9:30 P.M. 5 credits.

C-11, C-12, C-13, C-14 See E-92, E-94, E-103, E-105.

C-15 and C-16 General Colloid Chemistry. The basic general principles of colloidal chemistry, followed by elementary analyses of important problems encountered in amorphous materials such as paints, cellulosic products, leather, paper, and textiles. Lecture, 7–9:30 P.M. 5 credits.

C-23, C-24, C-25, C-26 Textile Chemistry and Dyeing. The action of chemical reagents on the natural and synthetic fibers; the preparation of fibers for dyeing; the application of all classes of dyes to cotton, wool, silk, synthetic and union materials; and the testing techniques involved in measuring fastness to light, washing, crocking, perspiration, etc. One lecture, 7–9 P.M., and two laboratories, 7–9 P.M., per week.

CH-101 and CH-102 College Chemistry. Two semesters of Inorganic Chemistry, open to those who have passed C-32 or a satisfactory course in high school Chemistry. Two lectures, 7–9 P.M., and one laboratory, 6:30–9:30 P.M., per week. College level; 4 credit hours per semester.

E-1 Alternating-Current Machinery Laboratory II. Tests on the single-phase and three-phase induction motors, the brush-shifting motor, investigation of induction motor windings, and tests on the Amplidyne generator. 2½ credits.

E-2 Advanced Electronics Laboratory II. Discriminators, ratio detectors, limiters, reactance modulators, phase modulators, networks in FM circuits, video amplifiers, television pulse generators and deflection circuits, frequency dividing circuits, such as counters and multivibrators. 2½ credits.

E-3 Advanced Electronic Laboratory I. Phase inverters, push-pull audio amplifiers, transformer coupled audio amplifiers, intermediate frequency amplifiers, frequency mixers, detectors, distortion in audio amplifiers, testing and alignment of complete receivers, frequency multipliers, crystal oscillators, power oscillators, audio oscillators, Class C RF amplifiers, amplitude modulated r-f amplifiers, balanced modulators, RF transmission lines. 2½ credits.

E-4 Advanced Paper Technology. Details of manufacture of various papers and their conversion to a useful end product. Guest lecturers supplement the regular staff.

E-5 Algebra. Fractions, functions, linear and quadradic equations, equations in quadratic form, graphs, exponents, complex numbers, binomial expansion, variation, and equations of higher degree than the second. 2½ credits.

E-6 Alternating-Current Machinery. Construction and principles of operation of the constant potential, constant current, autotransformer, and other types of transformers are considered with emphasis on the vector diagrams, core losses and methods of test. Principles of operation of the a-c induction motor, synchronous motor and alternator. The theory of operation, characteristics, load conditions and methods of testing. 2½ credits.

E-7 and E-14 Algebra. Algebra, including addition, multiplication, subtraction, division, factoring and fractions.

E-8 Alternating-Current Machinery Laboratory I. Experiments on a-c power circuits, polyphase circuits and power measurements, constant potential transformer tests, constant current transformer, and synchronous machinery. 2½ credits.

E-9 and E-16 Algebra. A continuation of E-7 and E-14. Some of the topics treated are: graphical representation, linear equations, radicals, quadratic equations, logarithms, slide rule, and some trigonometry.

E-10 Alternating-Current Theory. Sinusoidal electromotive forces and currents, effective value, power and energy, power factor, complex and polar notations, a-c series and parallel circuits, resonant conditions, and elementary polyphase systems. 2½ credits.

E-11 Analytical Geometry. Straight line, circle, and conic sections, using rectangular cartesian co-ordinates only; also the graphs of trigonometric, logarithmic, and exponential equations. With E-13, 2½ credits.

E-12 Air Conditioning — Heating and Ventilation. The principles of air conditioning covering the fundamental laws, physical properties of the atmosphere, measuring instruments, heating, cooling, humidification and dehumidification systems, air filtration, refrigeration, etc. Lectures and assignments.

E-13 Differential Calculus. Differentiation of algebraic, trigonometric, exponential, and logarithmic functions, both explicit and implicit; slopes of curves; maxima and minima; derivatives of higher order, velocity and acceleration in rectilinear motion. With E-11, 2½ credits.

E-15 Applied Leather Analysis. A subject designed to acquaint the student with the accepted methods of analysis of the American Leather Chemists Association and other supplementary procedures. 2½ credits.

E-17 Applied Mathematics. Designed for students who need a review of the fundamental processes of and includes some plane and solid geometry, algebra, logarithms, and trigonometry. Use of the slide rule is stressed in the solution of practical problems.

E-18 and E-19 Applied Mechanics. (E-114, taken concurrently if necessary, and E-99.) The fundamentals of statistics and kinetics, including such topics as force systems, laws of equilibrium, centers of gravity, moments of inertia, analysis of stresses in framed structures, momentum, energy, work and power, and the dynamics of the translation and rotation of rigid bodies. 5 credits.

E-21 and E-23 Architectural Drawing. The first semester covers problems of detailing and alteration such as a young draftsman might encounter in an architect's office. The second semester takes up design of a small house including floor plan, elevations, section, details, heating, plumbing and electrical drawings, as well as cost estimates.

E-24 Blueprint Reading. The principles of mechanical drawing, *e.g.*, projections, sections, dimensioning, etc., necessary for the understanding of blueprints.

E-25 Blueprint Reading. Similar to E-38, but with emphasis on architectural, rather than engineering, blueprints.

E-26 and E-27 Calculus and Analytic Geometry. The first semester covers differential calculus with the necessary analytic geometry; the second semester covers integral calculus. 8 credits.

E-28 Chemistry of Plastics. The chemical structure of high polymers and their manufacture and preparation. The chemical reactions of plastics and their physical properties in relation to their chemical structure. This subject is designed for those in the plastics industry who desire to keep abreast of modern theory or broaden their background. College level; 2 credit hours.

E-29 Direct-Current Machinery. Shunt, series, and compound motors and generators, problems of commutation, armature reaction, losses, efficiencies, stray power, ratings, methods of test, protective devices, application of d-c machinery to industry is also involved. 2½ credits.

E-30 Diesel Engines. An elementary study of Diesel engines, their operation, and maintenance. Types of Diesels, fuel oils, fuel injection systems, combustion, cooling systems, application, maintenance, etc. Lectures and assignments.

E-31 Direct-Current Machinery Laboratory. Tests are performed on the d-c shunt, series and compound motors, d-c shunt and compound generators. Experiments on parallel operation of d-c generators, stray power and opposition tests. 2½ credits.

E-32 Electronics for Industry Laboratory. Experiments are performed on the diode, triode, photo-tube and Thyratron, control of motor speed and generator voltage by electronic circuits, induction and dielectric heating, ignition three-phase rectifier, the Thyratron six-tube rectifier, resistance welding control and automatic synchronization. 2½ credits.

E-33 Direct-Current Theory. Electromotive force, current flow, resistance, conductance, circular mil, Ohm's law, series and parallel d-c circuits, d-c power and energy, primary and secondary cells, Kirchoff's laws, Superposition and Thevenin's theorems, d-c instruments, magnetic and electrostatic circuits. 2½ credits.

E-34 Electronic Laboratory. Electron emission, gas diodes, triodes, filter circuits, iron core reactors, Thyratrons, half and full wave rectifiers, voltage regulated power supplies, grid controlled rectifiers, voltage amplifiers, resistance coupled cascade amplifiers, feed-back amplifiers, photo cells and their applica-

tions, cathode ray tubes and oscilloscopes. Use of impedance bridges and vacuum tube voltmeters. (Must be taken concurrently with E-36.) 2½ credits.

E-35 Electronics. A more advanced treatment of the fundamentals of electronics than E-40, offered for those who have completed college mathematics and physics. Topics included are: alternating current circuits, fundamental properties of thermionic and photoelectric tubes, amplifiers, rectifiers, oscillators, coupled circuits, and filters. College level; 3 credit hours.

E-36 Electron Tubes and Circuits II. Distortion; decibels; input admittance; resistance and transformer coupling; d-c amplifiers, photo-tube amplifiers; current amplifiers; volume control methods; sources of noise; maximum power output; plate efficiency; push-pull amplifiers; classes A, AB, and B operation; and feedback amplifiers; radio frequency amplifiers of both voltage and power type; class B and C operation and their design; neutralization; and frequency multiplication. 5 credits.

E-37 Electronics for Industry. Basic electron tubes, electronic control and regulation circuits, high vacuum diode and triode, Thyratron, and photo-tube, amplifier theory, rectification and filtering, and general industrial control circuit applications. 2½ credits.

E-38 and E-45 Engineering Drawing. Freehand and mechanical drawing, including lettering, geometric construction, orthographic projection, isometric and cabinet drawing, and dimensions, auxiliary views, cross sections, advanced dimensioning, sketching of machine parts, working drawings, tracing and blueprinting, intersections, and developments. 5 credits.

E-39 Electronic Physics. Fundamental principles of waves, with particular applications to electromagnetic radiation. Interference, diffraction, and polarization. Antennas and the properties of the ionosphere. 2½ credits.

E-40 Frequency Modulation and Television. Wire photo, radio photo, facsimile and then television. Electronic television systems, using the iconoscope and image orthicon for transmission, and cathode ray tube for reception. Synchronizing circuits and problems. Video amplifiers, deflecting circuits, television transmitters, receivers and antennas. 5 credits.

E-41 Electron Tubes and Circuits I. Theory of electron emissions, by thermionic, photo-electric, secondary and field means, construction and processing of the various types of cathodes. The construction and evacuation of tubes, diode tube with the space charge phenomena, control of electrons in vacuum tubes. Static and dynamic characteristics of various tube types, amplifier circuits, rectifier action, addition of gas in vacuum tubes, and discharges in gas-filled tubes. 5 credits.

E-42 and E-47 The Fundamentals of Electronics. Topics include: vacuum tube theory, vacuum tube applications including rectifiers, power supplies, amplifiers, classes of amplifiers, voltage gain and power amplifiers, electronic instruments, etc. Lectures and laboratory.

E-43 Electrical Measurements. D-C and A-C measurements of voltage, current, power, resistance, capacitance, inductance, impedance, frequency, tube characteristics, etc. The factors limiting the precision of the results are analyzed. 2½ credits.

E-44 and E-51 Geometry of Engineering Drawing. The theory of orthographic drawing and the study of space relationships of lines, planes, and solids.

E-46 and E-53 Heat Engineering. The principles of elementary thermodynamics, the properties of steam, mechanical mixtures, and combustion of fuels. 5 credits.

E-48 Hydraulics. Properties of fluids; statics of fluids; flotation; relative equilibrium; dynamics of fluids, Bernoulli's theorem, measurement of velocity and pressure; cavitation; flow of viscous fluids; Reynolds' number; flow in pipes; flow with free surface; critical depth; weirs; orifices and nozzles; impulse and momentum in fluids; resistance of immersed and floating bodies. Froude's number, boundary layer; dynamics of compressible fluids, Mach's number; dynamical similitude and Pi theorem. 2½ credits.

E-49 Fundamentals of Plastics. An introductory study for those who wish to acquire a general knowledge of plastics. Classification, description, chemical and physical properties, uses, and methods of fabrication.

E-50 Industrial Electronics. The theory and operating characteristics of gas and vacuum tubes, photo-electric cells, and the thyratron. Topics covered include: amplifiers, electronic relays and timers, thyratron applications, phase shifts, inverters, rectifiers, motor and welder control, textile and other applications. Lectures and laboratory.

E-52 Integral Calculus. Methods of integration; use of integral tables; definite integrals; areas in rectangular co-ordinates; length of curves; areas of surfaces of revolution; volumes of solids of revolution; multiple definite (iterated) integrals; centroids of plane areas; moment of inertia. 2½ credits.

E-54 Leather Histology. A study of the structures of animal skin and of the changes which they undergo in the leather-making process. Because the basically extracellular nature of skin demands it, considerable time is devoted to the nature and function of the fundamental protein constituents. 2½ credits.

E-55 Job Evaluation and Merit Rating. Theory of wage calculation, job elements and their definitions, rating scales, writing job descriptions and specifications, selection of appropriate rating plan, setting up job factors and maximum point values, methods of determining specific point values. Development of wage structures. 2½ credits.

E-56, E-57, E-58, E-59 Leather Technology. Introduction to the technology of leather manufacture. The first two semesters are devoted to examining government regulations in imported hides and skins, studying the purchasing of hides and skins, and classifying various hide damages. This is followed by work on the handling of raw stock at the tannery, unhairing, bating, and hide classification. The third and fourth semesters are concerned primarily with the study of vegetable tanning, chrome tanning, and various other types of tanning. In the work throughout the year the material covered in lectures is supplemented by laboratory studies on a small scale. 10 credits.

E-60 and E-61 Leather Technology. The theoretical aspects of leather production coupled with a laboratory to carry out the planning of process control, material control, and product quality control. One section will be devoted to an intensive introduction to the histology of hides and skins and histological preparations.

E-63 and E-65 Machine Shop Practice. Metal working, including bench work, lathes, grinders, planers, shapers, presses, milling machines, care of tools, tool grinding, heat treatment, forging, use of special tools, etc. The classes are limited to 25 students.

E-66 and E-67 Machine Design. The design of machine elements, such as fasteners, shafts, frames, bearings, gears, clutches, springs, keys and drives. Data for most of the problems are taken from actual machines in the various laboratories. 5 credits.

E-68 and E-69 Machine Drawing. Several short problems involving centers of gravity, counterweights, cam layouts, piping, welding, sheet metal drafting, and assembly drawings. 5 credits.

E-71, E-73, E-75, E-77 Mechanical Drawing. Fundamentals of engineering drawing. The first semester covers lettering, use of instruments, geometric construction, orthographic projection, multi-view and pictorial freehand drawing. The second semester includes dimensioning, auxiliary views, cross sectioning, screw threads and working drawings. The third semester offers intersections, pictorial drawings and applications to sheet metal drawings. The fourth semester covers assembly drawings from details of parts and detailing from designers' assembly drawings.

E-78 and E-79 Mechanical Engineering Laboratory. Calibration of instruments, performance of hydraulic equipment, steam equipment, heating units, air conditioning apparatus, internal combustion engines, and testing materials are performed. 5 credits.

E-80, E-82, E-91, E-93 Paper Manufacturing — Testing and Analysis. An elementary study of the fundamental processing techniques used in paper manufacture. The lecture work is accompanied by laboratory training in paper making, paper testing and analysis, and paper microscopy. 10 credits.

E-81 Mechanism. The basic principles of kinematics, in which the wide variety of process machinery available furnishes many specific examples. Frequent use of these mechanisms is made in the development of the subject. Some of the important topics covered are the following: rolling cylinders and cones, gearing, gear train design, epicyclic gear trains, flexible connectors including stepped pulley and cone design, cam design, linkages, and miscellaneous mechanisms. 2½ credits.

E-83 Mechanism. The principles involved in the transmission of force and motion through machines and mechanical devices. Topics covered are: mechanics, accelerated motion, moments of force, pulleys, belting, gears, cams, etc.

E-84, E-86, E-87, E-89 Paper Technology. Lectures on the production and technology of pulp and paper.

E-85 Oil Heating. Fundamentals of heating systems, oil burners, controls, installation, and service.

E-88 and E-97 Physics. Elementary physics on the high-school level. Lectures and demonstrations.

E-90 and E-99 Physics. Force; energy; work; statics; elasticity; linear, rotational and harmonic motion; liquids and gases, wave motion, sound, heat, light, and electricity. 5 credits.

E-92 and E-103 Plastic Technology. This is an introductory study of plastics. It includes history, classification, properties, definitions and uses. Raw materials, methods of manufacturing, processing and fabrication. Lectures and laboratory. 5 credits.

E-94 and E-105 Plastic Technology. Additional instruction in processing and fabrication. Applications of plastics, engineering properties, equipment, mold and product design. Testing of plastics. Lectures and laboratory. 5 credits.

E-95 Physical Testing of Leather. A practical and theoretical study of the characteristics of leather in relation to the end use. Studies are made on measuring and classifying the effect of changes in manufacturing procedure, both chemical and physical. Leather, because it is a natural product, varies considerably within the same hide. Thus, the nature of this variation is very important and the study of any changes affecting it is, in turn, important. 2½ credits.

E-96 Principles of Production and Planning. Analysis of the product to be manufactured; market and sales research; plant location; plant design, determination of required physical facilities; internal organization; engineering organization for development of product; distribution and control of engineer-

ing information; establishment of manufacturing budgets for control; production planning, inventory control policy, receiving and storekeeping, procurement; plant layout, and managerial controls to appraise manufacturing performance. 2½ credits.

E-98 Principles of Radio. Audio systems, microphones, loud-speakers, radio wave propagation, antennas, transmission lines, amplitude and frequency modulation, radio transmitters, modulators, detectors, receivers, tracking and alignment, servicing instruments, etc. Lectures and laboratory.

E-100 Research Problems in Leather. This subject is designed primarily to enable the student to put into practical application the various scientific principles of physics, chemistry, mathematics, economics, etc. on problems of an industrial nature. This may encompass anything from the design and layout of any of a number of special leather plants to the suggested solution of practical problems which arise in the operation of a modern business. 2½ credits.

E-102 and E-117 Fundamentals of Rubber Technology. An introductory course for those who wish to acquire a general knowledge of rubber technology. Physical properties, composition, compounding, vulcanization, evaluation, deterioration, etc., of various types of synthetic rubbers and natural rubber. Lectures and laboratory. 5 credits.

E-104 and E-119 Advanced Rubber Chemistry and Technology. Monomers, polymerization systems, relation of chemical structure to physical properties, theories of vulcanization, acceleration, reinforcement, and deterioration of elastomers. Lectures and demonstrations. 5 credits.

E-106 Semi-Conductors and Transistors. Nature of semi-conductors, crystal diodes, holes and the transistor, point-contact transistors, junction transistors, electronics of transistors, different methods of connections. 2½ credits.

E-107 Pulp and Paper Technology. The basic principles of manufacture of the common papermaking pulps, followed by a study of stock preparation and paper machine operation.

E-109 Pulp and Paper Testing Laboratory. Laboratory work in the physical and chemical testing of pulps and papers.

E-108 and E-123 Strength of Materials. Strength of materials, including such topics as simple stresses, strain, bending moments, shearing force, slopes and deflections in beams, beam design, torsion, and design of shafts. The work of the second semester deals with continuous beams, compound beams and columns, eccentric loading, combined stresses, reversals of stress, impact stresses, vibrations, and stress analysis by strain gage methods. 5 credits.

E-110 Strength of Materials. Tension, compression, shear, cast iron, wrought iron, steel, timber, design of bolts, tie rods, columns, boiler shells, riveted joints, beam theory, torsional stresses, shafts, etc.

E-111 Quality Control. This subject deals with the quality problem in manufacturing and approaches it through the use of statistical quality control. How to determine the true accuracy of a machine or process, how to distinguish between normal and abnormal variations in any process and how to use small sample plans for inspection are examples of topics covered. Prerequisite: Approval of the instructor. Normally requires two years of college or industrial experience. Statistics is not required. The class is limited to 25 students.

E-112 Transmission and Distribution Theory. Transmission line problems, phase components used in the solution of problems, protective station equipment and trends in the power industry. 2½ credits.

E-114 Trigonometry. Solution of all triangles by both natural and logarithmic functions, identities, radian measure, principal values and the solution of trigonometric equations. 2½ credits.

E-115 Communication Engineering. Neutralization circuits, including grounded grid amplifiers, LC oscillators, crystal oscillators, parasitic oscillations and special oscillator circuits, amplitude modulators. Antenna circuits, preselectors, mixers and converters, intermediate frequency amplifiers, and automatic volume control. Selectivity, sensitivity, stability, fidelity of receivers, modulators. 5 credits.

E-116 and E-129 Trigonometry. The solution of all triangles by both natural and logarithmic functions, identities, radian measure, principal values and the solution of trigonometric equations.

E-118 Work Simplification. Process and operation analysis through the use of process charts, flow diagrams, operation charts, man-and-machine charts, micromotion study, principles of motion economy. Work place layout, labor-saving tools and equipment, laboratory development work, practical applications of work simplification with particular emphasis upon cost analysis. 2½ credits.

E-121 Steam. Heat generation, transmission, and utilization. Topics covered are: heat and its measurement, use of steam tables, types of boilers, engines and turbines, boiler and engine room accessories, testing, etc. Lectures and assignments.

E-125 Textile Testing. A study of the methods used in the determination of the physical properties of textiles and the interpretation of test data. Topics include: a consideration of textile fibers and their properties, testing machines, breaking strength, elongation, fabric structure, tearing strength, thickness, bursting strength, crimp, twist, regain, etc. Lectures and laboratory.

E-127 Time Study. Introduction to wage incentives and current wage plans. History and development of time study, relation to motion and micromotion study, preliminary observation, technique of making time studies. Rating procedure, development of proper concept of "normal" performance, applying the rating and relaxation factors. Setting job and element standards, use of allowances, treatment of variables, introduction to standard data, synthetic standards, problems in the application of standards. 2½ credits.

G-1 and G-2 Accounting I and Accounting II. The principles of accounting. The first semester deals with the preparation and interpretation of reports and statements of financial position. The balance sheet, profit and loss statement, theory of debits and credits, ledger, etc., are covered. The second semester carries the student into payroll and tax accounting, partnership and corporate records and the basic principles of cost accounting.

G-3 and G-4 Appreciation of World Literature. Designed to increase the student's enjoyment of great literature of all types. The first semester covers American literature and its historical background; the second semester takes up British and Continental masterpieces.

G-5 Backgrounds of Latin America. The political, economic, social and cultural history of Latin America, including the Caribbean and Mexico, from the Spanish conquest to 1900. Some of the major topics are: the Colonial System, Wars of Independence and the Monroe Doctrine. Particular emphasis is placed on the influence of the United States upon Latin America's growth and development. College level; 3 credit hours.

G-6 American Foreign Policy. Backgrounds of various relations of U. S. with foreign nations. 3 credits.

G-7 Business Law. The basic legal principles of use to people in the conduct of their everyday affairs. Topics covered include contracts, mortgages, deeds, negotiable instruments, easements, conditional sales, partnerships and corporations.

G-8 Comparative Literature. This course aims to develop standards of literary criticism and to familiarize the student with six or more classics of western civilization. Lectures, class discussion, and critical papers form the basis of class meetings. College level; 3 credit hours.

G-9 Contemporary World Problems. The present-day issues of the world — communism, nationalism, imperialism, socialism, secularism, etc.—as they pertain to the individual's intellectual, physical and emotional life in society.

G-10 and G-13 Costume Design. The first semester studies methods of altering a commercial garment pattern to suit the requirements of any figure. The second semester deals with the drafting of original patterns.

G-11 Cost Accounting. An introduction to the study of the process of recording the expenses of operating a business from the standpoint of determining production and distribution costs.

G-12 Current Affairs. A study of current news relating to social problems as they pertain to the individual's intellectual, physical, and emotional life in society.

G-14 Delinquency and Crime. The study of crime as a social problem. The causes, characteristics and treatment of criminal behavior analyzed in non-technical language.

G-15 English Composition. The basic elements of composition, including remedial English, grammar, sentence structure, etc.

G-16 English Composition. Writing for business and social purposes. Narration, description, reports, letters, etc.

G-17 Fashion Illustration. Training in fashion illustration as applied to promotion and advertising display.

G-19 Foremanship. A study of foremanship principles and problems based on the Foremanship Management Conference Manuals of the National Foreman's Institute. It is designed to help men now acting as foremen in a more successful handling of their job and is conducted by the conference or seminar method, each man bringing in his own problems for analysis by the group. Some of the topics are: understanding people, the foreman as a leader, eliminating irritations, training workers on the job, getting along with the man above, eliminating waste, wage incentives, cost factors the foreman can control, etc.

G-21 Freehand Drawing. Drawing in charcoal from casts and group arrangements of still life.

G-22 Forces in Modern English and American Drama. The purpose of the course is to create an interest in the dramatic literature of Great Britain and America. Significant plays by Wilde, Shaw, Galsworthy, Synge, Yeats, O'Casey, Eliot, O'Neill, Odets, Anderson, Miller, and Williams will be read and discussed. College level; 3 credit hours.

G-23 Fundamentals of Public Relations. Basic techniques of press, radio, and television publicity with fundamental training in communications procedures, the social implications and professional responsibility of all media. Evaluation of promotional programs devised to create and ensure public awareness and goodwill.

G-24 Life Drawing. Drawing from the live model in charcoal or in pastel. Individual and class instruction in anatomy.

G-25 Great English and American Writers. Attention is focused on six or seven major writers. Emphasis will be on discovering what these authors have to say that is of interest or importance to the general reader today. The student will have the opportunity to determine the attitude toward life of each writer, to see what gave rise to this attitude, and to evaluate it and compare it with the views of other writers considered in the course. College level; 3 credit hours.

G-26 The Meaning and Use of Words. The exact meaning of words and how their proper usage can lead to clear and dynamic speech.

G-27 Industrial Psychology. A human relations approach to the study of the operation of basic psychological principles in industrial situations. The subject is designed for foremen and other supervisory personnel, not professional psychologists. Emphasis is placed on the relationships between worker efficiency and behavior, attitudes, fatigue, frustration, morale, motivation, etc. Some attention is given to causes of accidents and accident prevention, and to the problem of labor turnover. Selected case studies supplement text readings.

G-28 Modern Latin America. A continuation of G-5 covering the history of Latin America from 1900 to the present day. Some of the major topics are: Dollar Diplomacy, the Good Neighbor Policy, economic development and the increasing importance of Latin America in world affairs. College level; 3 credit hours.

G-29 Industrial Relations. The underlying principles of harmonious relations between employer and employee. Some of the topics covered are: company policies and the foreman, employee morale, grievances, wages, training, collective bargaining, unions, government regulations, arbitration, etc.

G-30 Pastel Drawing. Drawing in pastel from still life group arrangements.

G-31 Main Currents in Modern Drama. The purpose of the course is to impart an intelligent and enthusiastic interest in the theater of the Twentieth Century. Significant plays by Ibsen, Strindberg, Chekhov, Shaw, O'Neill, Miller, and Williams will be discussed. College level; 3 credit hours.

G-33 Principles of Advertising. The fundamentals of advertising: psychology, copy writing, layout, production, testing, campaigns, etc. Lectures and assignments.

G-35 Principles of Retailing. Stores—types, location, and organization. Merchandise—purchasing, preparing for resale, promoting, selling, advertising and displaying. Record keeping, planning, and merchandising calculations.

G-36 and G-41 Show Card Design. The preparation of commercial signs. The first semester deals largely with lettering and elementary layouts; the second semester teaches more elaborate layouts and designs executed in tempera paints.

G-37 Principles of Salesmanship. The fundamentals of salesmanship: the psychology of selling, building a selling talk, showmanship, elements of successful selling, wholesale and retail salesmanship, etc. Lectures plus student participation.

G-38 Techniques of Leadership. Designed to aid the industrial supervisor to relate his own behavior to that of the group under his supervision. The dynamics of leadership and of the group receive primary emphasis. The concepts, values, and limitations of democratic and authoritarian leadership are treated through case studies and textual readings. Leadership as expressed through inter-personal relationships, and the resolution of social conflict both by integration and the democratic process provide the practical basis for this subject.

G-39 Psychology. This course covers the fundamentals of psychology with particular reference to the group relationships of the individual.

G-40 Water Color. This course is designed to acquaint students with various styles and techniques of this popular medium and also to enhance their understanding of shape, form, line and texture and the rules of color harmony and contrast. Students will work from still-life groups and individual instruction will be given.

G-43 Silk Screen Printing. Stencilling and printing on textiles and paper with the silk screen.

G-45 United States History since 1865. Political, Social, Economic development of United States from reconstruction period to the present. 3 credits.

G-47 Vocabulary Building. A subject to help the student enlarge his vocabulary and improve his understanding and choice of words. Language roots and word evolution are also studied.

G-49 Writing for Profit. Creative writing for commercial use. Stress is laid on the creation and development of ideas in journalism, feature articles, short stories, and other forms of commercial writing. Student discussion and analysis of their own writings will be a major portion of the work.

M-1 Textile Mechanism and Calculations. The mechanisms and mathematics required for an understanding of textile machines. Pulleys, cones, gears, levers, cranks, revolutions, surface speed, constants, ratio, proportion, formulae, slide rule, etc. Lectures and demonstrations.

M-2 Technology of Natural and Man-made Fibers. Types of sheep and wool. Wool buying, selling, grading, sorting, scouring. Other animal fibers such as mohair, alpaca, camel, vicuna, etc. Man-made fibers, such as rayon, nylon, orlon, etc. Identification, tests, uses, properties. Theory and basic principles of yarn making by all systems. Explanation of mule spinning, frame spinning, roller drawing, porcupine drawing, pressed felt manufacture, etc. Lectures and demonstrations.

M-3A Yarn Manufacturing by Woolen System. The conventional woolen yarn system of picking and blending, carding and spinning, on both the mule and frame. Machine descriptions, adjustments, settings, maintenance, and processing techniques. Lectures and demonstrations.

M-3B Reprocessed and Reused Fiber Manufacture. The sources of reclaimed fiber, the sorting of raw materials and the carbonizing of rags. Rag picking, lumping, shredding, and garnetting. The Wool Products Labeling Act. Lectures and demonstrations.

M-3C Synthetic Yarn Manufacture on the Woolen System. Problems of processing synthetic fibers into yarn on woolen system machinery. The basic properties of synthetic fibers, techniques of processing, machine set-up, and special adjustments. Lectures and demonstrations.

M-4 Wool and Staple Synthetic Top Manufacture. The manufacture of wool or man-made fibers, such as cut staple rayon or synthetics, into top using some or all of the following operations: worsted type carding, backwashing, open and intersecting gilling, Noble Combing, Warner Swasey Pin Drafters, Holdsworth Gill Reducers. Mostly lectures, but sample lots of wool or synthetic fiber or blends are usually run in the laboratory as time permits.

M-5 Worsted and Synthetic Yarn Manufacture. Yarn making of wool or synthetic fiber or blends on the modified Bradford or English type of machinery. Roller drawing machines, worsted spinning frames, twisters and winders are studied as well as the newer short cut systems using the Warner Swasey Pin Drafter, Holdsworth Gill Reducer, etc. Other spinning systems, such as the Bird System, American System, Ambler, Saco-Lowell Draftall, Whitin Super-Draft are studied. Lectures and demonstrations, and sample lots of synthetics

and wool or blends of all types of fibers are made into yarn in the laboratory when time permits. Spinning covers all phases of flyer, cap, ring, direct and centrifugal systems. Production, scheduling and routing problems are discussed with actual mill procedures as subject matter.

M-6A Wool and Staple Synthetic French Combing. The combing of shorter wools or synthetics on the so-called French Comb. Advanced intersecting gilling and blending of wool with other fibers and blends of synthetics. Mostly lectures, but modern equipment is available in the laboratory and usually small lots of wool or synthetics or blends are run.

M-6B Wool and Staple Synthetic Yarn Manufacture on the French System. The manufacture of wool or synthetics or blends into a French worsted type yarn. Intersecting gilling, open gilling with rub aprons, French or porcupine drawing. Short cut French systems using Pin Drafters and super draft porcupines, French Frame spinning, ring and mule twisting, winding. Mostly lectures, but modern laboratory equipment is available for demonstrations and running sample lots.

M-7 Tow to Top — Synthetic and Man-made Fiber. This subject covers in detail the processes and operations necessary to make top or sliver from synthetic or man-made tow. A detailed study is made of the Pacific Converter, Perlok system, Saco-Lowell Direct Spinner, etc. Mostly lectures, but sample lots are run on a Converter as time permits.

M-8 Top Mill Organization. Methods of calculating unit costs, personnel, work loads, cost of top, machinery layouts, supervisory help, production engineering. The over-all picture of an integrated woolen and worsted mill is considered to show how the top mill fits into the complete picture. The top mill is considered in detail. Lectures only.

M-10 Woolen and Worsted Finishing. The finishing of both woolen and worsted cloths. Some of the topics covered are: burling, mending, fulling, washing, speck dyeing, carbonizing, gigging, napping, steaming, brushing, shearing, and pressing. Lectures and some demonstrations.

M-11 Cotton Yarns. First semester of cotton yarn manufacture. Properties and characteristics of raw cotton; cultivating, ginning and marketing of raw cotton; mixing, opening and picking, and carding.

M-12 Cotton Yarns. Second semester of cotton yarn manufacture. Combing, drawing, regular and long draft roving.

M-13 Cotton Yarns. Third semester of cotton yarn manufacture. Spinning, spooling, winding, and twisting.

M-14 Synthetic Yarn Manufacture on the Cotton System. The processing of staple synthetic fibers on the cotton system and the modifications of cotton type equipment to handle these fibers. The lectures are supplemented with laboratory work.

M-15 Knitting. Yarns, yarn sizing, and the manufacture of knitted fabrics and garments from all types of yarn.

M-18 Cotton and Synthetic Finishing. The methods of converting both cotton and synthetic fabrics from the gray to the finished state. All the major processes of both wet and dry finishing of these fabrics are discussed, including crease resisting, stabilizing, water repelling, flame repelling, heat setting, etc.

M-24 Loom Fixing. The timing of all different motions in the loom and remedies for improper settings. Box and harness chain planning and building. Lectures and laboratory.

M-27 Cotton and Synthetic Design. Cloth analysis and design beginning with plain fabrics and leading into stripes and plaids, plus the construction, yarn denier and filament count of various synthetic cloths.

M-28 Cotton Design. The design and analysis of more elaborate cotton fabrics, such as extra warp and extra filling figured cloths, corduroys, velvets, ply fabrics, Leno fabrics, etc.

M-29 Woolen Design. Cloth analysis and design, covering blanket, bathrobing, filling reversibles, extra warp and filling backs, figured effects, double cloths, plaid backs, triple cloths and four-ply fabrics.

M-30 Woolen and Worsted Design. This subject includes the more complicated fabrics, such as chinchilla, melton, and kersey, as well as suitings. Manufacturing costs of woolen and worsted fabrics are also covered.

M-32 Power Weaving and Warp Preparation. Warp preparation in all systems as well as the Draper and Stafford automatic looms. Lectures and laboratory.

M-33 Power Weaving. The more complicated looms are studied, including dobby and Crompton & Knowles looms, as well as the Warner Swasey weaving machine. Weaving is primarily on woolen and worsted fabrics. Lectures and laboratory.

M-51 Elementary Textile Design. Weaves of all types, from the plain weave through fancy and figured weaves. Harness draft and chain are worked out for each weave. Yarn numbering for all systems, including ply and fancy yarns.

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INVESTIGATION OF SOME OF THE EFFECTS OF RAYON STAPLE DENIER BLENDING ON YARN PROPERTIES

Clarence J. Pope*

INTRODUCTION

Fiber blending has often been done in recent years for economic reasons, usually using a rayon or other synthetic fiber with the higher-priced wool fiber to make an acceptable yarn and/or fabric at less cost. In some cases, cotton and synthetics have been blended, but this has been primarily to make a yarn or fabric with certain desirable characteristics possessed by each fiber. Blending of various synthetic fibers has also been successful. Here again, this has usually been done to obtain a particular advantage of one of the fibers used.

No published references have been found regarding blending of the type dealt with in this study, i.e., blending various fiber deniers of viscose rayon in varying proportions. It was felt that blending of this type should yield a yarn that would be better than a yarn made entirely of any one denier. This was believed to be true because the combination of the characteristics of the finer denier fibers with coarser denier fibers should produce a yarn that would be strong, even but fuzzy, lustrous, and with a hand neither particularly soft nor crisp.

THEORY

The blending of fibers in making a yarn is usually done (a) to make a yarn economically or (b) to improve yarn characteristics.

In order for a manufacturer of wool fabrics to make a competitive fabric, he has to use some lower-cost synthetic fibers with the higher-cost wool to reduce the cost of the final fabric. Of course, the synthetic used must have a wool-like feel and appearance also or the blend is not successful. Very little blending of synthetic and cotton fibers has been carried on for economic reasons in recent years because the price of these two fibers on the market has been about the same.

The second reason for blending is to give to the resultant yarn desirable characteristics of each of the fibers. When a cotton manufacturer desires a fabric with a fairly high degree of luster, he accomplishes it by blending rayon fibers with cotton fibers. On the other hand, a yarn or fabric of greater strength is made possible by mixing a fine-denier synthetic fiber with cotton fibers. The hand or feel of the ultimate yarn or fabric is crisper when a fairly coarse synthetic fiber is blended with cotton fibers.

Blending rayon fibers of one particular denier with rayon fibers of other deniers should produce a yarn with some of the characteristics of each. It is generally known that yarns spun from fibers of fine deniers are usually stronger than yarns spun from fibers of coarser deniers if the same yarn count is made and the same staple length used (1, 2). When deniers are blended, the resultant yarn should possess a proportionate percentage of the individual denier characteristics. For instance, when 25% of 1-denier fibers are blended with 75% of

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3-denier fibers, the yarn produced should still possess more of the properties of the 3-denier than of the 1-denier fibers. However, the small percentage of 1-denier fibers should improve the strength of the yarn, and perhaps the hand, over a straight 3-denier yarn. This could be used to advantage if the properties of 3-denier fibers were desired, but with an increase in strength. It was felt that the small percentage of 1-denier fibers would materially improve the strength without seriously affecting the other properties. However, if a softer hand were desired, the finer denier would tend to offset the harshness (1) of the coarser denier, and the yarn should be one that contained some of the softness of the 1-denier fiber. As a result of this sort of blending in varying proportions, each yarn should have slightly different characteristics.

In addition to the above, it was felt that when two deniers were blended and spun into a single yarn, the resultant or equivalent denier of the fibers in the yarn was changed. As an example, when 75% of the fibers in a yarn were 1½-denier and 25% were 1-denier, the equivalent denier of the fibers in the yarn was 1.33-denier. This was determined by the following formula:

$$\frac{1}{\frac{D}{P}} + \frac{1}{\frac{D_1}{P_1}} = \frac{1}{\frac{ED}{100}}$$

where D . . . . D_1 = denier of fibers used
P . . . . P_1 = percentage of fibers in blend
ED = equivalent denier

Since no information relating to this specific type of blending was found, background data were gathered from sources which had used viscose rayon fibers but in 100% composition. According to one source (3) the effect of the fiber denier on the skein strength and single strand strength was practically a linear relationship in both cases. The fine denier yarns had the greater strength. The strength decreased in almost a straight line as the fiber denier was increased. It was illustrated that as the fiber denier was finer, the elongation at the break was higher for medium counts of yarn; but, as the yarn count was made finer, the elongation of the finer denier fiber yarn was lower.

The methods of blending varied from blending the raw stock to blending at various stages during the processing. However, blending of synthetic fibers was usually done in the raw stock state because this normally gave a better mix. At any rate, the earlier the blending took place, the better, or more uniform, the blend was likely to be. This pre-picker blend was usually made up by laying out a layer of one type of fiber and then a layer of another type on top of the first and repeating this procedure until all of the two fibers were used. This was referred to as a "sandwich" blend and was recommended by various authorities (1, 4, 5). In feeding this blend to the picker, the operator customarily took an armful, reaching from the top to the bottom of the "sandwich," thus stimulating a "bite." This insured that intermingling of the fibers would occur in the processing machinery.

APPARATUS

1. Picker—Saco-Lowell (Kitson)
   Three beater single process

   a) Speeds

	Beater	*Fan*
1st	1120 r.p.m.	1000 r.p.m.
2nd	1165 r.p.m.	1100 r.p.m.
3rd	950 r.p.m.	1400 r.p.m.

b) Settings

Beater to feed rolls		Beater to grid bars
1st beater	$\frac{1}{4}''$	$\frac{3}{4}''$
2nd beater	$\frac{5}{16}''$	$1''$
3rd beater	$\frac{11}{32}''$	$\frac{3}{4}''$
Spike roll	$\frac{1}{2}''$	Distance between bars was as close as possible
Adjustable plate (blending reserve)		$10''$ from front of reserve box

c) Lap produced—12¾ ounces/yard

d) Relative Humidity

Conditioning – 45% at 67°F.
Processing – 60% at 80°F.

2. Card—Saco-Lowell Standard Card

a) Speeds

Cylinder	–	150 r.p.m. to 160 r.p.m.
Lickerin	–	310 r.p.m. to 330 r.p.m.
Doffer	–	6½ r.p.m. to 7 r.p.m.
Flat	–	2⅞″/min. to 3″/min.
Doffer Comb	–	1300 r.p.m.

b) Draft constant – 1526
Draft gears – 17, 18 and 19
Drafts – 89.7, 84.7 and 80.5

c) Sliver produced – 55 grains/yard

d) Settings

Feed plate to lickerin	–	.012″
Lickerin to cylinder	–	.007″
Back plate to cylinder	–	.022″
Top mote knife	–	.012″
Bottom mote knife	–	.010″
Flats to cylinder (back to front)	–	.010″, .010″, .010″, .009″, .009″
Front plate to cylinder	–	.029″
Screen to cylinder (back)	–	.029″
(middle)	–	.058″
(front)	–	.187″
Doffer to cylinder	–	.007″
Lickerin screen (back)	–	⅛″
(front)	–	.029″
Doffer comb to doffer	–	.012″
Flat comb to flats	–	.012″

e) Humidity

Conditioning – 50% at 80°F.
Processing – 60% at 80°F.

3. Drawing—Saco-Lowell, 4 delivery
Metallic rolls—$1\frac{3}{8}''$, $1\frac{1}{8}''$, $1\frac{1}{8}''$, $1\frac{3}{8}''$ diameters

a) Front roll speeds — 275 r.p.m.

b) Draft constant — 225.5
Draft gears used — 31 and 34

c) Roll settings — 1st Drawing
Front to 2nd — $1\frac{13}{16}''$ center to center
2nd to 3rd — $1\frac{15}{16}''$
3rd to back — $2\frac{3}{16}''$
2nd Drawing
Front to 2nd — $1\frac{7}{8}''$
2nd to 3rd — 2″
3rd to back — $2\frac{1}{4}''$

d) Tension gears — 1st Drawing — 35 and 36
2nd Drawing — 37 and 38

e) Sliver produced: 1st Drawing — 53 grains/yard
2nd Drawing — 50 grains/yard

f) Humidity
1st Drawing: 54-61% at 75° to 82°F.
2nd Drawing: 55-61% at 70° to 80°F.

4. Roving Frame—Whitin Super-Draft System

a) Speeds
Front roll — 170 r.p.m.
Spindle — 1000 r.p.m.

b) Draft constant: Back section — 200
Front section — 360
Draft gear used: Back — 50 teeth
Front — 66
Mechanical draft: Back — 4
Front — 5.45
Total draft — 21.8

c) Twist constant — 65.1
Twist multiplier — .815
Twist per inch — 1.55
Twist gear used — 42 teeth

d) Tension constant — 66.7
Tension gear used — 29 teeth

e) Lay constant — 33.9
Lay gear used — 20 teeth

f) Roll settings
Front to 2nd — $2\frac{3}{16}''$
2nd to 3rd — $3\frac{1}{4}''$ (fixed)
3rd to back — $1\frac{13}{16}''$

g) Hank roving produced — 3.63 hank

h) Humidity

55 to 64% at 69° to 80°F

5. Spinning—Fales & Jenks, 72 spindle frame
Whitin Casablancas Long Draft System

a) Speeds
Spindle — 4560 r.p.m.
Front roll — 190 r.p.m.

b) Draft constant — 738
Mechanical draft — 18.2
Draft gear used — 41

c) Twist constant — 502
Twist multiplier — 3.00
Twist per inch — 16.6
Twist gear used — 30

d) Lay gear used — 31

e) Size of traveler — 6 – 0

f) Roll settings—Whitin Casablancas Long Draft System

	Left Side	*Right Side*
Front to middle	1⅝″	1⅞″
Middle to back	1⅝″	1⅝″

g) Count produced — 30s single
(double roving fed)

h) Distance from apron to front roll

Left Side	*Right Side*
1/32″	9/32″

MATERIALS

Stock used: Viscose rayon, 1 9/16″, bright.
1 denier — extra strength
1½ denier — regular
3 denier — crimped

Source of stock: American Viscose Corporation

Analysis of stock:

A sample of each of the three fibers was tested on the Pressley strength instrument. Ten tests were made on each of the samples and an average break strength in pounds and an average weight in milligrams calculated. The break strength was then divided by the weight to obtain the Pressley index which was applied in the following formula to determine the pounds per square inch:

$$(10.8116 \times \text{Pressley index}) - .1200 = \text{pounds/inch}^2$$

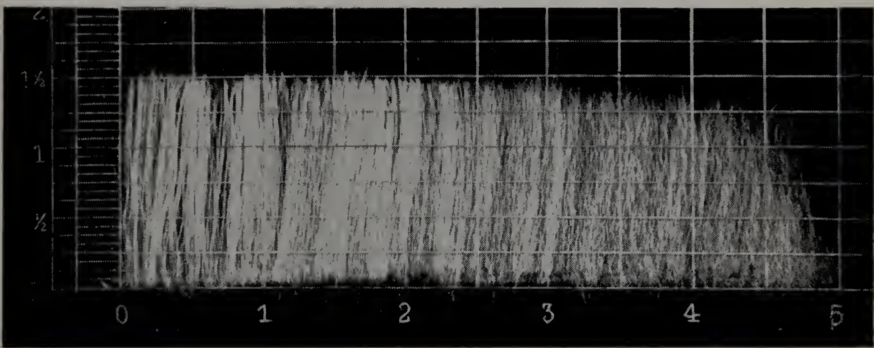
The results of this test are tabulated below:

Denier	*Pounds/square inch*
1	43,126.4
1½	43,018.3
3	45,396.0

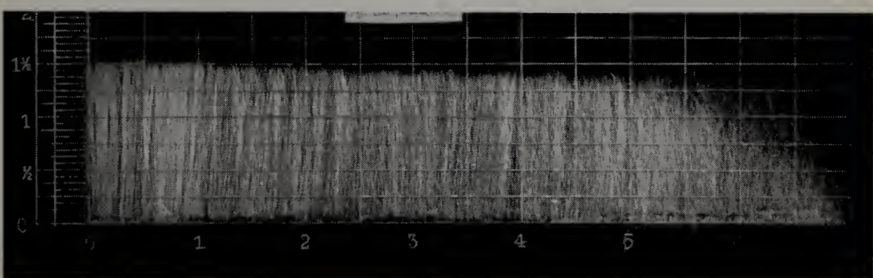
In addition to this a staple array of each of the fibers was made. The instrument used in this case was a Suter-Webb sorter. Photographs of these arrays appear on the following pages.

ORGANIZATION

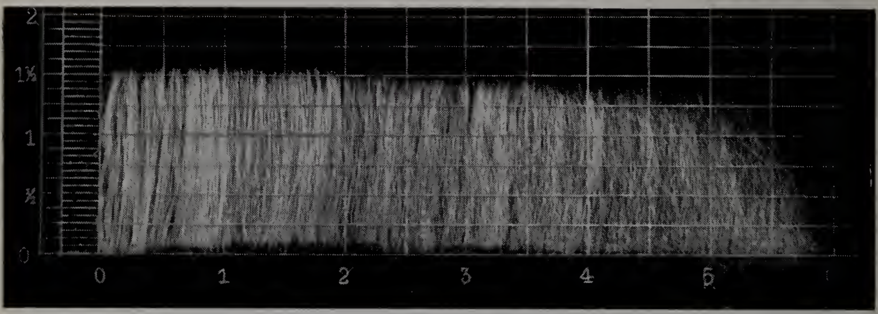
3.2%	Spinning Twist Contraction	.968	30	Final yarn count
	Draft Spinning	17.1	31	Yarn count at front roll
			1.815	Equivalent hank roving fed
			× 2	Doublings fed to spinning
	Draft Roving Frame	21.7	3.63	Hank no. delivered from roving frame
			.167	Hank no.
				or
			50	Grain sliver from 2nd drawing
			× 6.37	Draft 2nd drawing
	Doublings 2nd drawing	6	318	
			53	Grain sliver from 1st drawing
			× 6.22	Draft 1st drawing
	Doublings 1st drawing	6	330	
			55	Grain sliver from card
			× 97	Draft—Card
4.4%	Card Waste	.956	5335	
	Grains/ounce	437.5	5575	
			12.75	ounces/yard lap from Picker



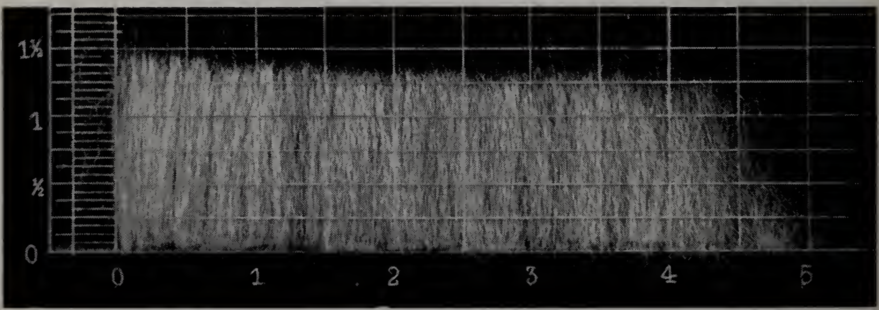
1 Denier — Raw Stock



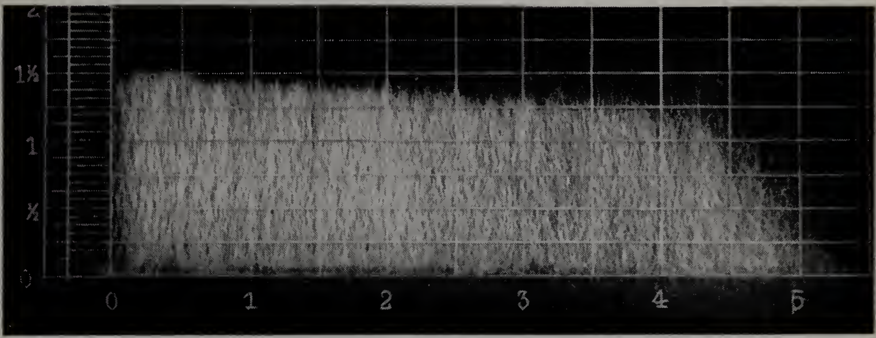
1 Denier — Card Sliver



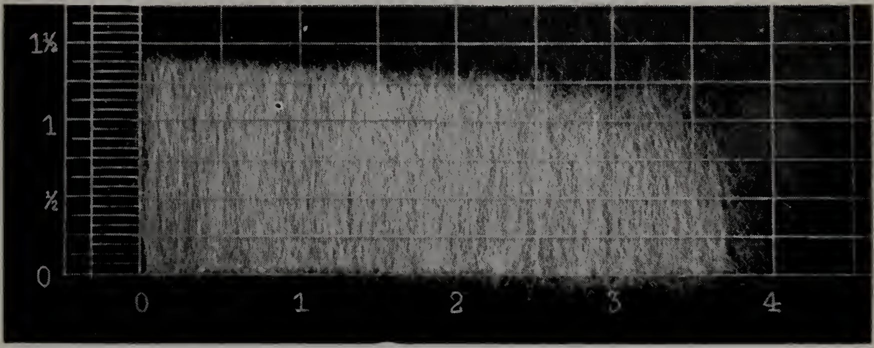
1½ Denier — Raw Stock



1½ Denier — Card Sliver



3 Denier — Raw Stock



3 Denier — Card Sliver

PROCEDURE

Blending

The method of approach to this problem was to blend the fibers in the raw state, i.e., before picking. In accomplishment of this step, the stock was weighed out into 12 lots of 25 pounds each. Three of the lots were entirely of one fiber, i.e., lot 1 contained 100% 1-denier fibers, lot 5 100% $1\frac{1}{2}$-denier fibers, and lot 9 100% 3-denier fibers. The other nine lots contained varying percentages by weight of two of the fibers (see Table I). These lots, once weighed, were spread out in layers to form a "sandwich" mix and allowed to condition for a period of approximately 24 hours at a relative humidity of 45% and a temperature of 67°F.

Picking

After the lots were conditioned, they were placed in the hopper feeder of the picker, one at a time, and in chronological order. The picker was adjusted to produce a lap of approximately 13 ounces per yard. Beater settings that were normally employed for cotton fibers were used, but the speed of the finisher beater was reduced from 1450 to 950 r.p.m., and the finisher fan speed was increased from 1000 to 1400 r.p.m. These changes were made in an effort to reduce fiber breakage and prevent laps from splitting.

These recommendations were made by several authorities reviewed during the literature survey (1, 6, 7). All speeds and settings were listed under Apparatus.

A tapered lap arbor or the use of paper tubes placed over the regular lap arbor was a recommendation made by some authorities (1, 6), so that the laps could be removed easily. Since a tapered lap arbor was not available, the latter method was used. In order to prevent the tubes from becoming crushed by the pressure exerted by the lap racks, this pressure was periodically relieved by a manual method.

The size of the laps was checked and found to be $12\frac{3}{4}$ ounces per yard which was considered satisfactory.

A relative humidity of 60% with a temperature of 80°F. was found to be necessary in order to relieve difficulties caused by static electricity.

Carding

Carding was performed on a standard cotton card (revolving flat top) made by the Saco-Lowell Shops. Regular cotton speeds and settings were used (see Apparatus).

It was found that the card ran smoothly and that nothing indicated that these settings or speeds needed changing.

The sliver averaged 54.8 grains per yard and was produced at a rate of about 9 pounds per hour. Each lot was processed through the card for one hour with a cardboard disk placed in the roving can at the end of each 10-minute period, thus dividing the lots into six relatively equal parts. The condition of the web was observed and also a nep count was made on each lot. The method used for making this count was to collect enough of the web onto a piece of black cardboard and count the neps on the area of the cardboard (10″ x 10″).

Drawing

The sliver was then processed through two drawing operations. The frame used was a 4-delivery, single-head Saco-Lowell frame equipped with metallic rolls. Because of the long staple length of the fibers, it was necessary to remove

the gear guard and disconnect the stop motion to obtain the proper roll settings (see Apparatus). Six ends of card sliver were fed to the drawing frame and a 53-grain sliver was produced. Each of the lots was run for ½ hour, with a circular cardboard disk placed in the roving can at the end of each 5-minute interval, thereby dividing the lots into six fairly equal parts. These parts were used for the six ends fed to the second drawing operation.

In the second drawing operation, it was found that the rolls had to be opened up more in order to prevent curling of the fibers. The rolls were moved back the maximum obtainable distance. With this setting, some curling of the fibers did occur in a few lots, but to a rather limited extent (see Apparatus for settings). Six ends of first-drawn sliver were fed to this operation producing a 50-grain sliver (see Apparatus).

It was found necessary to keep the tension slightly tight to prevent bunches from going into the sliver.

Roving

The drawn sliver was processed on a long draft intermediate roving frame with Whitin Super-Draft equipment. Six ends of each of six lots were processed simultaneously. To insure a sufficient quantity of roving, three partial doffs of each lot were produced. Some difficulty was also encountered in obtaining the correct roll settings here. Finally, it was necessary to reverse the sliver guide traverse cam so as to allow for a more open setting between the rolls.

The average weight of the slivers fed to the roving operation was 50 grains per yard. After the rolls had been set, it was necessary to determine the proper draft, twist, tension, and lay gears to use. Since the draft was divided into two zones, it was necessary to calculate draft in each zone and consequently the draft gear for each zone.

After the necessary change gears were calculated, a trial run was made. Based on the data obtained from this run, the proper size change gears were computed by proportion. Because of machine limitations, it was necessary to increase the twist to 1.55 turns per inch from the theoretical 1.38 turns per inch. The correct size lay gear was not available; therefore, partially to make up for the improper number of coils per inch, a smaller tension gear was employed. This caused the tension to be relatively slack. It was brought out by several authorities (1,8) that the tension must not be too tight as rayon staple is easily stretched, resulting in weak roving. It was found that the starting point of the belt on the cone had to be about 2 inches from the small end of the bottom cone. This measurement was made from the center of the belt to the end of the cone. Lots 5, 6, 11, and 12 were run with leather top front rolls, whereas the other eight lots used synthetic top front rolls. Since these leather rolls were of a slightly smaller diameter, the weighting device did not exert sufficient pressure on the rolls. A small piece of metal under the weight lever remedied the situation.

The actual hank produced averaged 3.63 hank roving, which was a little heavier than the 3.85 originally desired, but was felt to be close enough, and no adjustments were made to change it. The roving was run in 2 sets, 3 doffs per set. The first set consisted of lots 1 through 6 inclusive, and each doff consisted of 6 bobbins of each lot. The second set contained lots 7 through 12 inclusive, with the same number of doffs and bobbins per doff. Each doff consisted of bobbins 2⅞″ in diameter.

Spinning

After completing the roving operation, the stock was put in the creel of a Fales and Jenks 72-spindle spinning frame. Double roving was fed to each

spindle. The frame was such that there were 36 spindles on each side, with 6 spindles per section of the roll stand. Therefore, to make 12 bobbins of each lot meant setting it up so that each lot would use 6 spindles and spin 2 doffs. After calculating the draft, twist, and lay gears, they were put on the machine and a test run was made. In this test, one bobbin of yarn was spun from each of the 12 lots so that the yarn count and twist per inch could be checked. The ballooning at the traveler and the coils per inch were also observed during this test.

Ultimately, the average count of the yarns, the twist per inch, the coils per inch, and the proper size traveler to control ballooning were obtained.

After the test runs were completed, the entire machine was threaded up and started. The side running lots 1 through 6 seemed to have hard ends and consequently would not run. These lots contained larger percentages of the finer deniers, i.e., 1 and $1\frac{1}{2}$. On this side of the frame the rolls were reset, i.e., the front to middle and back rolls. The setting of the back to middle rolls could not be changed as it was fixed. At first, the middle and back rolls were moved back 1/16″ and later 1/4″ but neither adjustment showed any improvement in the drafting. It was decided to break out the roving on those lots and run the side that would draft properly. After about one-half of the bobbin was spun, the roving on the lots that had been broken out was replaced, one at a time. This time no hard ends appeared and the drafting was good. During the running of the first half of the bobbin, lot 9, which contained 100% 3-denier fibers, broke down continuously. On the second doff, all the roving was pieced in, and all lots ran smoothly with the exception of lot 9 which again would not spin properly. At about the mid-point of this doff, one of the two roving bobbins for each end spun was replaced with a bobbin of the third doff from the roving frame. This procedure made it possible to have one fairly large bobbin and one small-sized bobbin feeding into each end spun. The small bobbin removed was to be used to replace the other small one when it ran out, thus leaving two bobbins on the frame of about the same size.

On the third and fourth doffs the lots that were on the side of the frame with the rolls more open were transferred to the other side of the frame and vice versa. All roll settings and speeds are listed under Apparatus.

The completion of the fourth doff finished the manufacturing phase of this investigation. The next step was to analyze and test the spun yarn. These four doffs produced 24 bobbins in each lot. Half of these were spun with the rolls set more open than the other half. The bobbins were separated into two parts. Those spun with the rolls more open were referred to as the first set and those spun with the close roll settings as the second set.

TESTING

Uniformity

The uniformity of the card sliver and first-drawn sliver was tested, using a Saco-Lowell sliver tester. Approximately 15 yards of each lot were run through the tester. The average and maximum variations were computed and recorded.

The yarns were tested for uniformity by wrapping them around black boards and comparing them to standards. On this seriplane test, 25 wraps per inch were used. These boards were compared to cotton standards of the equivalent count and graded. The yarn uniformity was also checked on the Pacific Evenness Tester using a length of 32 yards at a machine speed of 12 yards per minute.

Strength and Elongation

The yarn was then tested for single-strand strength and elongation at the break on an I P –2 model, Inclined Plane tester. The yarn samples were allowed to condition in a room maintained at an atmosphere of 65% relative humidity at 70°F. for several days prior to testing. A 500-gram weight was used on the carriage of the tester. The chart used was a percentage chart so that the point of break as recorded on the chart was that percentage of 500 grams. Ten tests were made on each bobbin, making 120 tests per lot. At the moment during the test that the yarn broke, the percentage of the strength was recorded and a mark made on the chart so that the elongation at the break could be determined.

The next test was to determine the skein strength of the yarn. Skeins of 120 yards were reeled and allowed to condition before the test was made. A pendulum-type Scott tester was used to obtain the skein strength. This instrument also had a recording apparatus so that the elongation at the break could be calculated from the charts made. At first, it was decided not to record charts of the skein breaks due to the fact that the elongation of the skeins is relatively inaccurate. However, after about half the skein breaks were made, it was decided to make the charts anyway. A 200-pound capacity was used on the machine, thus the dial reading had to be multiplied by two to obtain the break in pounds.

BLENDS

Lot Number	1 Denier %	1½ Denier %	3 Denier %
1	100	—	—
2	75	25	—
3	50	50	—
4	25	75	—
5	—	100	—
6	75	—	25
7	50	—	50
8	25	—	75
9	—	—	100
10	—	75	25
11	—	50	50
12	—	25	75

RESULTS

Staple Arrays

The staple arrays of the 3 fibers are shown by the photographs on pages 9, 10 and 11. Arrays were made from samples of the raw stock and from samples of the card sliver produced. These arrays were studied to determine if the picking and carding operations had any serious effect upon the staple lengths of the fibers and consequently the strength of the yarn.

Uniformity

1. *Sliver Tests*

The sliver tester charts of the card sliver and first drawing sliver were analyzed. The average variation per yard was calculated along with the maximum variation for each lot on both sets of charts. A length of about 16 yards was tested of each lot of the two types of silver.

Table A was prepared in order to indicate the average variation per yard in percentage and the per cent maximum variation.

TABLE A

PER CENT VARIATION OF CARD AND DRAWN SLIVER

Lot No.	% Av. Variation		% Max. Variation	
	CARD	DRAWN	CARD	DRAWN
1	17.1	33.1	25.0	46.5
2	14.3	31.0	24.4	36.0
3	13.0	35.2	23.8	43.2
4	13.6	31.3	30.0	44.0
5	13.4	32.8	26.5	48.6
6	13.5	30.8	22.5	37.3
7	14.4	28.7	23.9	41.5
8	15.1	29.7	24.5	42.5
9	15.1	31.9	43.6	47.5
10	13.4	37.6	23.4	50.0
11	14.7	27.7	32.1	37.0
12	14.3	33.7	25.5	41.3

2. Yarn Test

The seriplane boards of each lot of yarn were compared with cotton standards of the equivalent count for yarn evenness. Two bobbins of each lot were checked. Table B was made to show the evenness of the two samples of each of the lots.

TABLE B

SUMMARY SERIPLANE TESTS

Lot No.	GRADE	
	Sample — 1st Set	Sample — 2nd Set
1	B+	A—
2	A	A—
3	A	A+
4	A	A+
5	A	A+
6	A—	B+
7	A—	A—
8	A—	A—
9	B+	A—
10	A	A
11	A	A
12	A	A+

The per cent average unevenness and maximum unevenness were computed from data obtained from yarn tests performed on the Pacific Tester and are presented in Table C.

TABLE C

PACIFIC TESTER UNIFORMITY TESTS

Lot No.	% Av. Unevenness	% Max. Unevenness
1	50.4	66.4
2	50.2	64.6
3	46.1	93.4
4	54.5	102.6
5	52.5	82.9
6	52.5	92.0
7	63.5	99.5
8	66.1	110.6
9	68.7	103.9
10	56.6	85.7
11	62.8	106.3
12	66.6	110.0

Single Strand Elongation

The single strand elongation at the break, in per cent, was determined from the charts. These figures were recorded and an average elongation was calculated for each set of each lot. These results were tabulated in Table D. Since no correction was necessary due to differences in count, the actual readings from the charts were the only ones listed.

TABLE D

SUMMARY OF SINGLE STRAND ELONGATION

	ELONGATION %	
Lot No.	1st Set	2nd Set
1	13.5	13.5
2	13.9	13.4
3	14.3	14.1
4	14.1	14.0
5	14.6	14.8
6	12.9	12.7
7	11.8	11.9
8	10.9	11.1
9	10.1	10.4
10	13.3	13.4
11	11.6	11.9
12	11.2	11.3

Skein Elongation

The skein elongation, in inches, was determined by an inclined plane tester. Due to the fact that, for every inch of elongation in the yarn, 2.21″ were shown on the chart, the inches of elongation taken from the chart had to be divided by this constant. Table E was prepared in order to show the average elongation and the corrected average elongation.

TABLE E

SUMMARY OF SKEIN ELONGATION

Lot No.	Av. Elongation	Av. Corrected Elongation
1	5.73	2.59
2	5.38	2.44
3	6.07	2.74
4	6.05	2.73
5	5.93	2.68
6	5.71	2.58
7	4.87	2.20
8	4.02	1.82
9	3.61	1.63
10	5.49	2.48
11	4.47	2.02
12	3.92	1.77

Single Strand Strength

After the testing was completed, the data were analyzed. Although the average count of the 12 lots was the 30s single desired, a great many of the lots were either slightly above or below this count. Due to this fact, the single strand breaks, when computed from the percentage chart, had to be corrected to 30s yarn. Table F shows the actual percentage readings from the charts, the corrected percentage readings and the strength in grams.

TABLE F

SUMMARY OF SINGLE STRAND STRENGTH

	Actual % Settings		Corrected % Settings		Grams Setttings		Grams/Denier Settings	
Lot No.	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1	66.6	64.3	65.6	67.1	327.5	335.5	1.84	1.89
2	69.2	67.7	62.7	63.4	313.5	317.0	1.76	1.79
3	69.2	66.3	61.8	62.1	309.0	310.5	1.74	1.75
4	62.8	61.4	62.2	61.1	311.0	305.5	1.75	1.72
5	59.7	61.6	60.7	63.2	303.5	316.0	1.71	1.78
6	64.1	64.6	60.2	60.7	301.0	303.5	1.70	1.71
7	55.6	54.1	56.9	55.7	284.5	278.5	1.60	1.57
8	48.3	48.9	51.0	51.5	255.0	257.5	1.44	1.45
9	44.1	44.3	49.1	45.5	245.5	227.5	1.38	1.28
10	56.5	57.0	56.7	57.2	283.5	286.0	1.59	1.61
11	50.1	50.9	52.9	52.8	264.5	264.0	1.49	1.49
12	50.0	50.3	50.0	50.1	250.0	250.5	1.41	1.41

Skein Strength

With the skein breaks, it was necessary to apply a machine calibration correction factor to the scale reading. The scale reading in this case was a percentage reading of the machine capacity. Using a 200-pound capacity, the scale reading was that per cent of the 200 pounds or the reading multiplied by two to obtain the actual strength in pounds after the correction factor had been applied. When the skeins were broken, they were weighed on a grain scale so that the count could be computed. Then a break factor was calculated so that the break strength could be corrected to the count (30s single).

Table G was prepared in order to show the scale readings, break strengths, weights, counts, break factors, and the corrected break strength for each of the two settings.

TABLE G

Summary of Skein Strength

Wide Setting

Lot No.	Scale Reading	Break Strength	Weight (Grains)	Count	Break Factor	Corrected Break Strength
1	43.2	86.4	33.8	29.6	2557.4	85.2
2	45.9	91.8	36.7	27.2	2496.9	83.2
3	45.0	90.0	37.3	26.8	2412.0	80.4
4	38.2	76.4	33.7	29.7	2269.1	75.6
5	34.9	69.8	32.8	30.5	2128.9	70.9
6	40.9	81.8	35.5	28.2	2306.7	76.8
7	34.65	69.3	32.6	30.7	2127.5	70.9
8	28.65	57.3	31.5	31.7	1816.4	60.5
9	25.35	50.7	32.2	31.1	1576.7	52.5
10	34.65	69.3	33.2	30.1	2085.9	69.5
11	30.3	60.6	31.5	31.7	1921.0	64.0
12	29.15	58.3	33.3	30.0	1749.0	58.3

Close Setting

Lot No.	Scale Reading	Break Strength	Weight (Grains)	Count	Break Factor	Corrected Break Strength
1	41.5	83.0	32.0	31.3	2597.9	86.6
2	41.2	82.4	35.8	28.1	2315.4	77.2
3	45.1	90.2	35.6	28.1	2534.6	84.5
4	40.0	80.0	33.4	29.9	2392.0	79.7
5	37.9	75.8	32.4	30.8	2328.5	77.8
6	42.5	85.0	35.5	28.2	2397.0	79.9
7	32.25	64.5	32.8	30.5	1967.3	65.6
8	28.35	56.7	31.6	31.6	1791.7	59.7
9	25.05	50.1	32.5	30.8	1543.0	51.4
10	33.85	67.7	33.2	30.1	2037.8	67.9
11	29.75	59.5	32.2	31.1	1850.4	61.6
12	29.25	58.5	33.4	29.9	1749.0	58.3

Summary of Single Strand and Skein Strength

Table H shows the skein and single strand strengths compared with lot 1.

TABLE H

SUMMARY OF SINGLE STRAND AND SKEIN STRENGTH

	Single Strand Tests				Skein Tests			
	Wide Setting		Close Setting		Wide Setting		Close Setting	
Lot No.	Gms.	%	Gms.	%	Lbs.	%	Lbs.	%
1	327.5	100	335.5	100	85.2	100	86.6	100
2	313.5	95.5	317.0	94.6	83.2	97.6	77.2	89.1
3	309.0	94.3	310.5	92.7	80.4	94.3	84.5	97.6
4	311.0	95.0	305.5	91.0	75.6	88.8	79.7	92.1
5	303.5	92.5	316.0	94.2	70.9	83.1	77.8	89.6
6	301.0	91.8	303.5	90.5	76.8	90.0	79.9	92.2
10	283.5	86.4	286.0	85.4	69.4	81.4	67.9	78.4
7	284.5	86.9	278.5	83.1	70.9	83.1	65.6	75.7
11	264.5	80.6	264.0	78.8	64.0	75.0	61.6	71.2
8	255.0	77.8	257.5	76.8	60.5	71.0	59.7	69.0
12	250.0	76.3	250.5	74.8	58.3	68.4	58.3	67.3
9	245.5	74.9	227.5	67.9	52.5	61.5	51.4	59.3

Equivalent Deniers

Equivalent fiber deniers were calculated by the formula on page 4 and arranged in order from the finest to the coarsest in Table I.

TABLE I

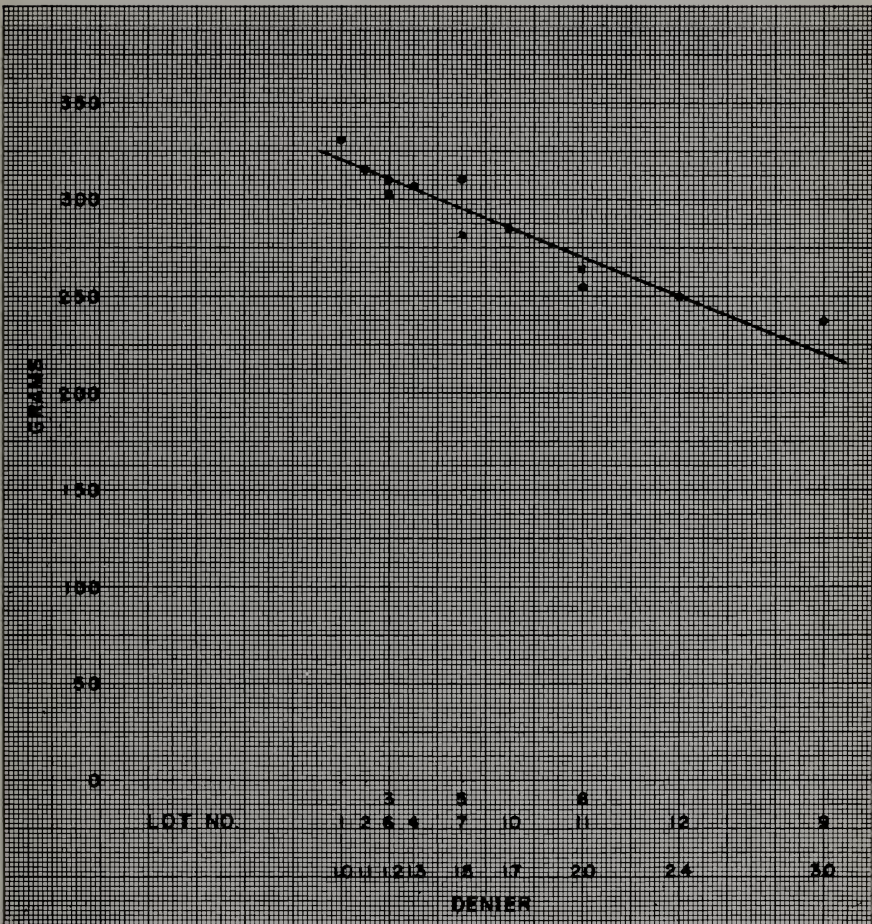
EQUIVALENT FIBER DENIERS

	% Denier			
Lot No.	1	1½	3	Equivalent Denier
1	100	—	—	1.00
2	75	25	—	1.10
3	50	50	—	1.20
6	75	—	25	1.20
4	25	75	—	1.33
5	—	100	—	1.50
7	50	—	50	1.50
10	—	75	25	1.70
8	25	—	75	2.00
11	—	50	50	2.00
12	—	25	75	2.40
9	—	—	100	3.00

CHARTS

Chart No. 1 (prepared from Tables F and I) demonstrates the effect of the single-strand strength plotted against the equivalent fiber denier. The strength readings of the close and wide settings were averaged and this latter figure was plotted on Charts Nos. 1 and 2. The data contained in Table I indicated that the equivalent fiber denier in three instances was the same; therefore, lots 6, 7, and 11 are represented by an x on Charts Nos. 1 and 2, whereas lots 3, 5, and 8 are shown by the same symbol as all the other lots on these charts. Chart No. 2 (prepared from Tables D and I) illustrates the relationship of single-strand elongation versus the equivalent fiber denier. Chart No. 3 (prepared from Tables D and F) plots the single-strand strength against elongation.

CHART NO. 1

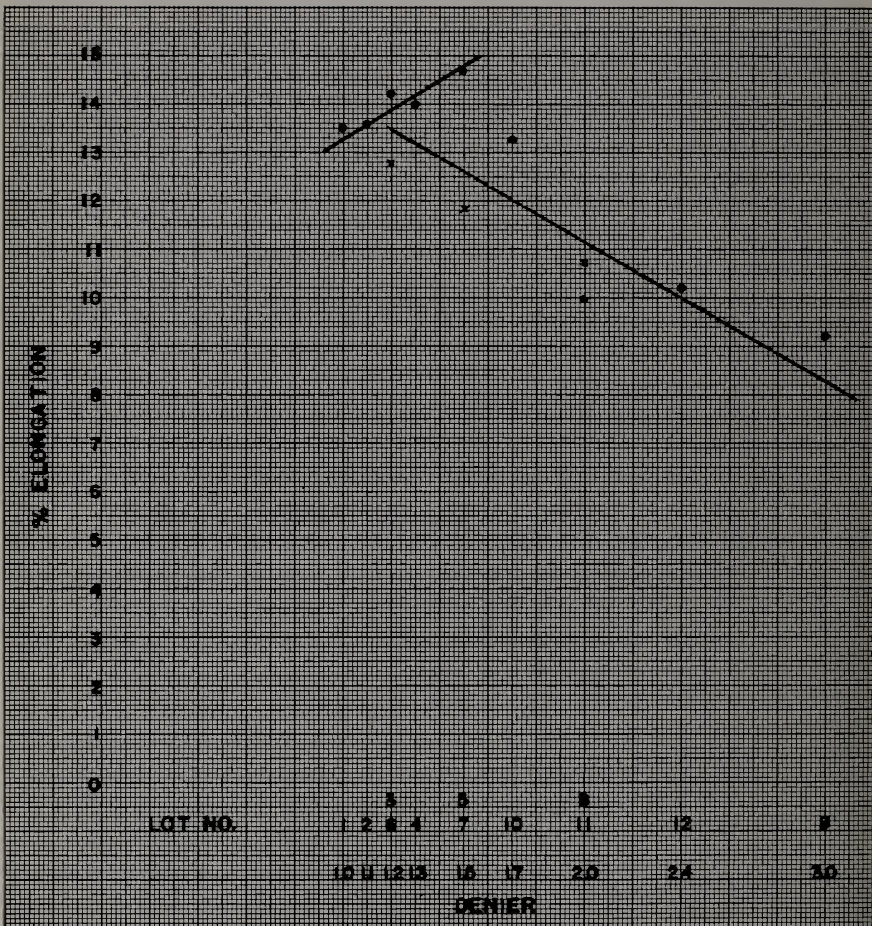


SINGLE STRAND STRENGTH VS. EQUIVALENT FIBER DENIER

x = average of wide and close settings for lots 6, 7, and 11.

o = average of wide and close settings for all other lots.

CHART NO. 2

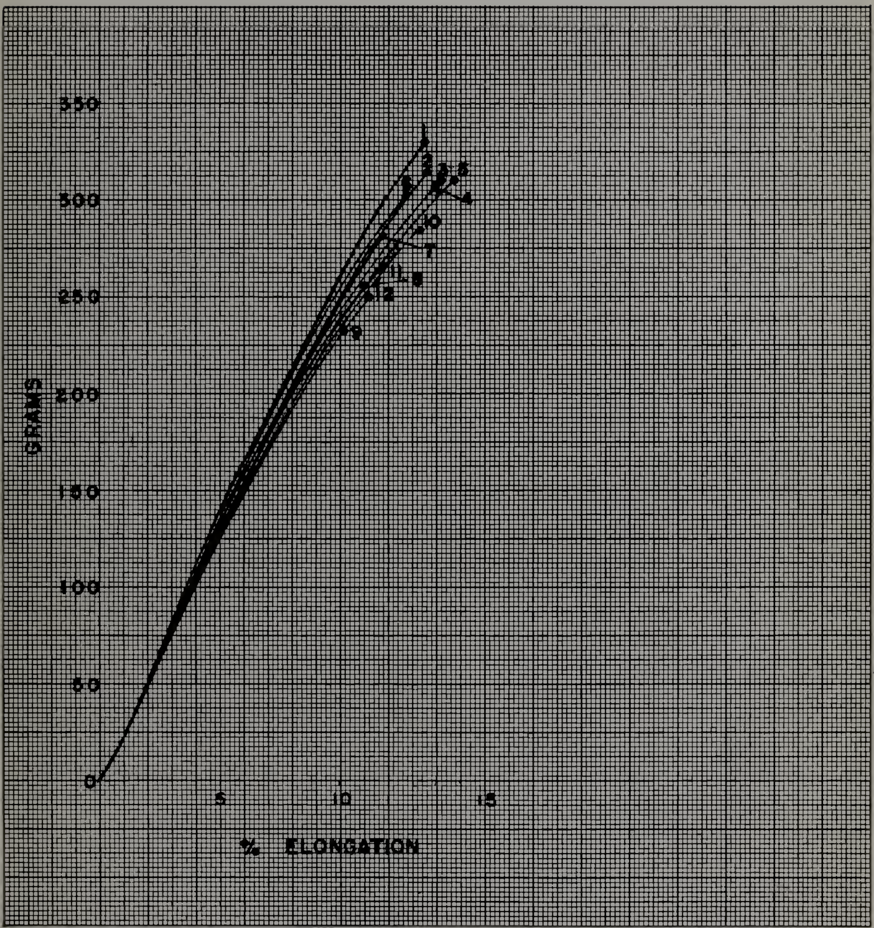


SINGLE STRAND ELONGATION VS. EQUIVALENT FIBER DENIER

x = average of wide and close settings for lots 6, 7, and 11.

o = average of wide and close settings for all other lots.

CHART NO. 3



Single Strand Strength vs. Elongation

DISCUSSION

Staple Arrays

Comparison of the arrays of the raw stock and card sliver indicated that very few fibers were damaged during the picking and carding operations. Since the staple length remained practically the same, the strength of the yarn made from these fibers should not have been decreased due to the processing treatment. The arrays of the fibers after carding did show a slightly greater percentage of shorter fibers, but the average staple length of the fibers was about the same.

Uniformity

The first measure of evenness or uniformity was taken on the card sliver using a Saco-Lowell sliver tester. The results are shown in Table A. Lot 3 appeared to be the best, with lot 1 having the poorest uniformity. From these figures, the lots made up of 1- and 1½-denier fibers seemed to be slightly better than the other lots, as a whole, considering average variation. This trend was not continued in the drawn sliver. Lots 7, 8, and 11 appeared to have less average variation in the drawn slivers. All those lots contained some 3-denier fibers.

In comparing the various lots for yarn evenness, the seriplane test revealed that all of them were good. The majority of the lots averaged grade A or A—; however, three of the lots were slightly lower in grade than the others. Those lots were 1, 6, and 9. Lot 1 was of a lower grade probably because it had the highest number of neps according to the nep count taken of the card web. Although lot 9 had no visible neps in the card web, a great deal of difficulty was experienced in spinning this lot. Due to the fact that it was made entirely of 3-denier fibers, it did not spin well into a count as fine as 30s single. As a matter of fact, it broke down repeatedly, and thus a large number of piecings were made which undoubtedly had an adverse effect upon the uniformity of the yarn. Lot 6 was probably more uneven than most of the others because it contained a large per cent of 1-denier fibers mixed with a small per cent of 3-denier fibers. Tables B and I, when used together, showed that the more 1½-denier used in the blend, the more uniform the yarn regardless of whether it was mixed with 1-denier fibers or 3-denier fibers. Also compared were lots 5 and 7. Both had an equivalent denier of 1½, but lot 5 was entirely of 1½-denier fibers whereas lot 7 was a blend of 1- and 3-denier fibers. Lot 5 was among the very best for uniformity while lot 7 was slightly poorer in this respect. The samples of the second setting (the closer roll settings) were more even than those of the first setting, probably because greater control of the fibers was maintained.

The uniformity data obtained by the Pacific Tester indicated that the lots containing mixtures of 1½-denier and 1-denier fibers were the most uniform.

Single Strand and Skein Elongation

The elongation at the break of the single strand is shown in Chart No. 2. It was noted that as more of the 1½-denier fibers were added to the blends of the 1-denier fibers, the elongation increased rather sharply. It appeared that 1½-denier regular fibers had more extensibility than the other fibers. Lot 5, which was 100% 1½-denier, demonstrated the highest elongation of all the yarns. Lot 7, which was equivalent to 1½-denier but contained 1- and 3-denier fibers, exhibited a much lower percentage of elongation. Lot 10 again illustrated that the presence of 1½-denier had a definite effect on the stretch. This lot was one in which ¼ of the fibers were of the relatively poor elongating 3-denier, but

still showed an elongation comparable to the 1-denier fibers. Chart No. 2 indicated that as the equivalent denier of fibers became coarser, the per cent elongation was increased up to $1\frac{1}{2}$-denier, but as the fiber denier was still coarser than this, the elongation dropped off in an approximate linear relationship. Chart No. 3 illustrates the effect of $1\frac{1}{2}$-denier fibers in the yarn. Also, this chart indicates the effect of 3-denier fibers on the elongation at the break of the yarn in single strand. Lot 9, which was composed entirely of 3-denier fibers, had the poorest elongation at the break. Lots 6 and 10 both contained 25% 3-denier fibers, but the elongations were not the same. This indicated that small percentages of 3-denier had little effect upon reducing the elongation, but as the percentage increased the effect became definitely noticeable.

Due to the fact that the 1-denier fibers were of extra strength, some of the fibers' elongation was probably removed during the manufacturing of the original tow from which the fibers were made. The tow was drawn out somewhat to make these fibers of extra strength, consequently some of the extensibility of the fibers was removed. Thus, the elongation of the lots containing 1-denier fibers was not so high as it would have been had these fibers been of regular strength as were the $1\frac{1}{2}$- and 3-denier fibers.

Single Strand and Skein Strength

The results of this investigation clearly indicated that as the fiber denier was increased, the yarn strength decreased. This was demonstrated both by the single strand test and by the skein tests. Chart No. 1, in which the grams of strength were plotted against the equivalent fiber denier, shows this relationship. The figures used for this chart were taken from Table A. The fiber denier shown on the horizontal axis is listed from fine to coarse. Although all the points do not fall exactly on the line, the line does bisect several, and there are about as many points above the line as below it. This effect of denier blending on the yarn strength as measured in the single strand indicates that as the equivalent denier becomes coarser, the strength falls off in an approximate linear rate. However, even though the equivalent fiber denier of lots 5 and 7 was the same, the single strand strength of lot 5 was the greater of the two. This was probably due to the fact that lot 5 was composed entirely of $1\frac{1}{2}$-denier while lot 7 contained 50% 1-denier and 50% 3-denier fibers. Apparently this amount of 3-denier fibers was sufficient to cause a lowering of the strength of the finer denier fiber so that the combined strength was lower than a straight $1\frac{1}{2}$-denier fiber yarn.

The differences in strength in the single-strand test were not great, and the skein test data indicated very little difference between lots 5 and 7. Therefore, it is felt that the blending of different fiber deniers did result in an equivalent fiber denier that was reasonably accurate. The trend of the skein test very closely approached that of the single-strand test.

From Chart No. 2 it was seen that as the denier of the fibers increased, the strength decreased in a linear relationship. The data in Table H indicate that the close settings yield a slightly stronger yarn as far as the single strand is concerned, but make very little difference on the skein breaks. About 2% greater strength is shown by the close setting than by the wide setting on the single-strand tests.

This investigation was made using standard cotton machinery throughout. Only one fan speed and one beater speed of the picker were changed from those speeds customarily used on cotton fibers. Nothing was changed as far as the card was concerned. Only roll settings, which are dependent on staple length, were altered on the drawing frame. Less twist was used on the roving frame and spinning frame as recommended (1, 8), and except for roll settings

the staple rayon was handled as cotton would have been but with less tension. Various speeds have been recommended (1, 4, 7, 9, 10) but most of these were not followed. It was felt that since the staple arrays did not show any appreciable fiber breakage and the strength of the yarn was reasonably good, normal speeds and settings used for cotton could be used with a minimum of changes. The relative humidity used was generally higher than would be used for cotton. Recommendations as to relative humidity were followed in order to eliminate static difficulties (1).

CONCLUSIONS

Staple Arrays

The staple arrays proved that any decrease in strength was not due to fiber breakage. It has been proved that if the staple length decreased, the strength of the yarn would consequently decrease, provided the count of the yarn remained unchanged. The staple arrays illustrated that very few fibers were broken during normal picking and carding operations. The arrays of card sliver samples did show a slight tapering off near the tail end which indicated slight fiber breakage but, to all intents and purposes, the average staple length was unchanged.

Uniformity

The variations of the card and drawn sliver, indicated by the charts made on the sliver tester, were not evident in the yarn on the seriplane test. This may have been true because too short a length of yarn was used on the seriplane boards. These variations would be evident in the weights used in the skein test. Since these weights were relatively uniform, it was concluded that the subsequent operations along with the doublings used in spinning tended to minimize sliver variations. These variations in the sliver were of the short-term type. Had they been long-term variations, undoubtedly the effect would have been seen in the seriplane boards or at least reflected in the skein weights. The seriplane board test and the Pacific Tester for yarn evenness proved that if the card web contained a comparatively high nep count, the yarn was more uneven. This was illustrated by lot 1 which had a nep count about 4 times the average. This theory did not work when applied to lot 9 which had no neps but was one of the poorest lots in yarn evenness, because it repeatedly broke down during spinning and required many piecings. This excessive end breakage was, no doubt, due to the fine count spun with this relatively coarse denier fiber (100% 3 denier). Normally, 20s single was recommended (6) as the optimum count to spin from 3-denier fibers while this test dealt with 30s single.

It was concluded that while the small change in spinning frame roll settings had no apparent effect on the yarn strength, it did have an effect on the evenness of the yarn. As shown in Table F, the samples made with the close setting (2nd setting) were of a higher grade or more uniform than those spun with the open roll setting (1st setting).

Elongation

In regard to the elongation at the break of the single strand, this investigation demonstrated that as 1½-denier fibers were present in the blend to a greater per cent, the elongation became greater in a straight line relationship up to an equivalent denier of 1½. This was clearly shown by lots 5 and 7. Lot 5 which was made up entirely of 1½-denier fibers had the greatest amount of elongation at the break. On the other hand, lot 7 was of an equivalent denier of 1½ but

made up of 1-and 3-denier fibers and, therefore, did not have as much elongation. The difference between these lots was 2.8%. It was concluded that even as the fiber denier became coarser up to 1½ denier, the elongation at the break increased in a linear relationship, but as the equivalent denier became coarser than 1½ denier, the elongation dropped in a linear relationship regardless of the fiber denier combinations. The elongation at the break of the skein indicated this to a much lesser degree. Lot 2 had less elongation than any of the lots in which 1½-denier fibers were used. With the exception of this reading, it was evident that the presence of 1½ denier in the blend did have an effect on the elongation, but not to the same extent as was exhibited with the single strand. The difference of the roll settings had no apparent effect upon the elongation at the break.

Chart No. 2 clearly shows the effect of 3-denier fibers on the elongation. As the percentage of 3-denier fibers in the yarn increased, the elongation decreased. Small percentages of 3-denier fibers did not have much effect upon the elongation, but as the percentage of these coarse fibers in the yarn increased, there was a definite tendency toward decreased elongation at the break.

It was concluded that the greater the percentage of 3-denier fibers in a yarn, the less the yarn will elongate provided all other factors remain equal.

The elongation of the 1-denier fibers was undoubtedly reduced because these fibers were of extra strength. In attaining this extra strength, the fibers were stretched during the manufacturing process which consequently removed some of the fibers' residual extensibility. Tests that have been made on continuous filament yarns indicated that extra strength or high tenacity yarns had less elongation than yarns of regular strength (11). In view of these facts, it was concluded that had the 1-denier fibers been of regular strength, the elongation shown in Chart No. 2 would have been a straight line passing through the points of all the equivalent fiber denier yarns rather than two separate lines as indicated. In other words, the line probably would have been a descending line with the highest amount of elongation at lot 1 and the lowest at lot 9.

Strength

This experiment further proved that if the equivalent denier of the fibers remained fine, regardless of the denier of the individual fibers making up the blend, the yarn still was stronger than an equal count yarn made from a coarser equivalent denier. Both the single strand strength test and the skein strength test indicated the same general trend and in approximately the same degree. That is, as the denier of the fibers became coarser, the rate of loss of strength was about the same.

Lots 5 and 7 both were of the same equivalent fiber denier. Lot 5, however, was entirely composed of 1½-denier fibers while lot 7 contained 50% 1-denier fibers and 50% 3-denier fibers. On the single strand strength tests, lot 5 was stronger, but practically no difference was indicated by the skein strength tests. The difference in either case was not great; therefore it was concluded that no matter what fibers the equivalent denier contained within 1 to 3 denier, the strength would be equal or practically so. Since the relationship of the strength to the equivalent denier was a straight line, the strength of any equivalent denier fiber yarn of the same count could be predicted on the basis of this investigation. Any prediction beyond either of these limits probably would not be accurate since no data were obtained to support them.

As a check, several equivalent fiber deniers were substituted in the following equation:

$$\text{Strength} = 372 - (50)\ (\text{denier})$$

The strength was computed, and this calculated strength, in each case, very closely approximated the actual strength of the yarn. It was then felt that the straight line fitted the points of the chart and that other strengths of deniers between 1 and 3 could be estimated with reasonable accuracy. The single strand tests were composed of 120 breaks for each lot.

The wide setting and the close setting of the rolls of the spinning frame had very little effect on the strength of the yarns. This was true provided the distance between the first and second rolls was no greater than 1/4". Therefore, it was concluded that the setting of the rolls on a long draft spinning frame had no serious effect upon the strength of the yarn.

General Conclusion

This investigation proves conclusively that fiber denier blending modifies the physical properties of yarn. The finer the denier of the fibers in a yarn, the greater number of fibers per cross section in a given count yarn; thus the yarn is stronger, provided the staple length is not changed (8).

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